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Taxonomic and Biological Studies of Neotropical Fig Wasps (Hymenoptera: Agaonidae)[1]

WILLIAM RAMÍREZ B.

ABSTRACT

Seven new species of New World *Blastophaga* which develop in the receptacles of figs of the subgenus *Urostigma,* section *Americana,* are described. The hosts of several previously described agaonids have been found or corrected. *Urostigma* species were found to be always pollinated by *Blastophaga* and *Pharmacosycea* species by *Tetrapus,* as was supposed by Müller in 1887 but contrary to views of certain recent authors.

Blastophaga wasps of the New World are all placed in the subgenus *Pegoscapus* and are characterized by the presence of corbiculae on the front coxae (except *B. mariae* and *B. carlosi*) and the mesosternum. These structures are used to carry pollen; little or none is carried in the gut or on the body surfaces. *Tetrapus* females do not possess corbiculae but much pollen was found in the digestive tracts and on the body surfaces of specimens examined.

The sizes of the bodies and ovipositors of the species of *Blastophaga* studied were different. Larger *Blastophaga* usually develop in species of *Ficus* which possess larger receptacles.

Since their wasps are quite host specific, *Ficus isophlebia, F. jimenezii,* and *F. tuerckhemii* are three well defined biological species as described by Standley in 1917, and not just one species *(F. tuerckheimii). F. hemsleyana* and *F. turbinata* are also well defined species, each with its own pollinator, and not one species *(F. citrifolia).* Each of the pharmacosyceous *F. crassiuscula* and *F. glabrata* has its own pollinator (*Tetrapus costaricanus* and an undescribed *Tetrapus* respectively), and thus should not be considered as one species *(F. insipida).* These conclusions concerning fig species are contrary to the recent views of DeWolf.

INTRODUCTION

The purposes of the present work are to clarify the generic status of New World Agaonidae, to describe seven species of *Blastophaga* which have been

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collected from New World figs *(Ficus),* subgenus *Urostigma,* section *Americana,* to present comparative and host data on other species together with some comments on fig species, to provide a key to Costa Rican Agaonidae, and to summarize biological information on New World Agaonidae.

It is well known that species of *Ficus* are absolutely dependent for pollination upon small wasps of the family Agaonidae, but there are arguments about the specificity of these pollinators. Van der Pijl (1960) indicated surprise that the genus *Ficus,* each species with its own gall wasp pollinator, still flourishes. Baker (1961) did not accept the specificity of fig wasps; however, in a later publication (Baker and Hurd, 1968) he changed his view and points out that in the enormous genus *Ficus* a unique situation prevails in which almost every species of fig has a recognizably different chalcidoid pollinator.

At present there is strong evidence that agaonid wasps are very specific to their hosts. It is also known that different genera and subgenera are quite specific to the different groups of figs (Wiebes, 1963; Hill, 1967a).

In the New World there are two subgenera of *Ficus, Urostigma* and *Pharmacosycea. Urostigma* is represented by section *Americana,* and *Pharmacosycea* by section *Pharmacosycea* (Corner, 1958).

Pharmacosycea and *Urostigma* in the New World are pollinated by different genera of agaonids, *Tetrapus* and *Blastophaga* respectively; there are no other New World agaonids. Müller (1887) correctly stated that *Tetrapus* appears to be limited to *Pharmacosycea.* Wiebes (1963) also reported that *Tetrapus* wasps develop in *Pharmacosycea* (section *Pharmacosycea*). Hill (1967a,b), however, considered that *Tristaniella* and *Secundeisenia* (=*Blastophaga*) also develop in section *Pharmacosycea,* an error resulting from misidentification of figs by earlier workers.

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MATERIALS AND METHODS

Sources of the agaonids: The material was collected mostly by the author in Costa Rica from 1964 to 1967. Some figs and wasps, however, were collected in Venezuela, Panamá and San Andrés Island, Colombia, during the years 1966 and 1967.

The places and dates of collection are given in Table 1. The country is omitted for Costa Rican localities.

The species of *Ficus* studied were: *F. colubrinae* Standl., *F. coombsii* Warb., *F. costaricana* (Liebm.) Miq., *F. crassiuscula* Warb., *F. glabrata* H.B.K., *F. hemsleyana* Standl., *F. isophlebia* Standl., *F. jimenezii* Standl., *F. lapathifolia* (Liebm.) Miq., *F. nymphaeaefolia* P. Mill., *F. obtusifolia* H.B.K., *F. oerstediana* Miq., *F. schippii* Standl., *F. torresiana* Standl., *F. trachelosyce* Dugand, *F. tuerckheimii* Standl., *F. turbinata* Pitt., *F. velutina* Willd. and *Ficus* No. 4.* *F. aurea* Nutt., *F. myriacycea* Pitt. and *F. radula* H. and B. were studied in less detail.

Floral cycle of figs: Galil and Eisikowitch (1968) divide the developmental phases of a syconium in a useful way which I have followed, thus:

Phase A (Pre-female): young syconium prior to the opening of the ostiole.

Phase B (Female): ostiolar scales loosen, female flowers ripen, sycophilous wasps penetrate into the syconium and oviposit into the ovaries.

Phase C (Interfloral): wasp larvae and fig embryos develop within their respective ovaries. Ovaries occupied by the larvae are transformed into galls.

Phase D (Male): male flowers mature, wasp reach the imago stage, fertilized female wasps leave the syconia via channels bored by the males.

Phase E (Post-floral): both the syconia and the seeds inside them ripen.

Measurements of wasp structures were made with an eyepiece micrometer at 430 × for mandibles and for the mesosomal dorsum of the male, 30 × for body length and ovipositor length. Ten specimens were measured in all cases except for *Blastophaga ileanae,* for which only five were available. Measurements given are means, except for ranges shown for mandibles in Table 2.

Collecting of fig wasps and figs: Individual syconia which were starting to ripen were collected from each species of *Ficus.* The best fruits were those starting to change color and to soften. Each fig was opened into halves and placed in a small jar that contained on the bottom some dry toilet paper in order to absorb moisture from the fig. Once all the wasps emerged from their galls, usually one day after the opening of the figs, a small section of toilet paper wet with gasoline was put inside the jar to kill the wasps. Once

* *Ficus* No. 4 is very common in Estado Sucre, Venezuela. It is characterized by the presence of sessile and geminate figs, which are green when ripe and measure about 2 cm in diameter. The leaves are glabrous, basally cordate, and apically obtuse. A specimen is deposited at the University of Costa Rica, Department of Biology Herbarium, as *Ficus* No. 4, Venezuela, collector William Ramírez.

TABLE 1. *Fiscus* Species and Localities Involved in this Study.

	Vial No.	Place	Date
Subgenus *Urostigma*			
F. colubrinae	13	Puerto Viejo, Heredia	May 16, 64
F. coombsi	438	San Andrés Island, Colombia	Aug. 5, 67
F. costaricana	27	La Luisa, Sarchí, Grecia, Alajuela	Apr. 16, 64
F. hemsleyana	44	Sarchí, Alajuela	July 17, 64
	45	Santo Domingo, Heredia	July 19, 64
	46	Hatillo No. 2, San José	July 21, 64
	432	Munegro, Cumaná, Sucre, Venezuela	July 15, 66
F. isophlebia	48	Ciruelas, Alajuela	Aug. 20, 64
	196	Camino Playas del Coco, Guanacaste	June 2, 67
F. jimenezii	51	Alajuela	Apr. 1, 64
	53	San Pedro de Poás, Alajuela	Apr. 1, 64
	54	Uriche, Heredia	Apr. 10, 64
	55	Santo Domingo, Heredia	Apr. 19, 64
	59	Barba, Heredia	May 6, 64
	60	Barba, Heredia	June 3, 64
	219	Paraíso, Cartago	Dec. 20, 66
	220	Arenal, Tilarán, Guanacaste	July 15, 65
	221	Arenal, Tilarán, Guanacaste	July 15, 67
F. lapathifolia	66	Grecia, Alajuela	May 25, 64
	191	Hatillo No. 2, San José	June 14, 64
F. nymphaeaefolia	176	Puerto Viejo, Heredia	May 16, 64
F. obtusifolia	172	Playón de Aguirre, Puntarenas	June 27, 64
	210	Grecia, Alajuela	Aug. 3, 64
	212	Tilarán, Guanacaste	July 14, 67
	213	Arenal, Tilarán, Guanacaste	July 14, 67
	215	Camino Cañas, Tilarán, Guanacaste	July 15, 67
	433	Ancon Hill, Canal Zone, Panamá	1967
	434	Barro Colorado Island, Canal Zone, Panamá	1967
F. oerstediana	88	La Virgen, Heredia	May 31, 64
F. schippii	169	Puerto Viejo, Heredia	May 16, 64
F. torresiana	4	Pejibaye, Turrialba, Cartago	July 29, 64
F. trachelosyce	174	Playón Aguirre, Puntarenas	July 2, 64
	230	Arenal, Guanacaste	July 14, 67
F. tuerckheimii	144	Potrero Cerrado, Cartago	Jan. 11, 64
	147	Poasito, Alajuela	May 6, 64
	149	San Jerónimo, Moravia, San José	May 1, 64
	154	Poasito, Alajuela	May 13, 64
	157	Los Angeles San Rafael, Heredia	May 23, 64
	158	El Roble, Heredia	May 31, 64
	159	San Jerónimo, Moravia, San José	May 1, 64
	160	Cot, Cartago	Mar. 12, 64
	161	Vista de Mar, Coronado, San José	Apr. 22, 64
	162	San Rafael, Heredia	Apr. 23, 64
	163	El Roble, Heredia	June 1, 64
	166	San Rafael, Heredia	June 23, 64
	217	Parque Central, San José	June 8, 67

	Vial No.	Place	Date
F. tuerckheimii x *F. jimenezii*	185	El Roble, Heredia	June 2, 64
F. turbinata	435	Santa Rosa, Sucre, Venezuela	June 2, 66
	436	Cumaná, Sucre, Venezuela	July 15, 66
	437	Panamá Viejo, Panamá	Mar. 18, 67
F. velutina	177	La Cañada, Cot, Cartago	Jan. 31, 63
	241	Paraíso, Cartago	Dec. 19, 66
Ficus No. 4	431	Cumaná, Sucre, Venezuela	June 27, 66
Subgenus *Pharmacosycea*			
F. crassiuscula	256	Vara Blanca, Heredia	July 16, 64
	257	San Vito de Java, Puntarenas	Mar. 24, 67
	258	San Vito de Java, Puntarenas	Mar. 24, 67
	260	La Carpintera, La Unión, Cartago	June 12, 67
	262	La Carpintera, La Unión, Cartago	June 12, 67
	263	Vara Blanca, Heredia	June 8, 67
	264	Canaán, Cerro Chirripó, Cartago	June 26, 67
F. glabrata	276	Puerto Viejo, Heredia	May 16, 64
	285	San Antonio de Belén, Heredia	Aug. 24, 64
	295	Río Guacimal, Guanacaste	Dec. 29, 66
	296	Miraflores, Canal Zone, Panamá	Dec. 12, 67

dead, they were brushed from the jar and the fruits. The agaonids were separated from their parasites and each species and its parasites was kept in a separate vial of 70% alcohol.

At the same time that wasps were collected, botanical material was obtained, pressed and dried for identification. The species of figs were identified using the papers by Standley (1917) and DeWolf (1960), and vouchers were deposited in the University of Costa Rica, Department of Biology Herbarium.

Dissection and mounting of the wasps: Each wasp was dissected in a depression slide in 70% alcohol before KOH treatment. Small hooks made of *minuten nadeln* mounted in sticks of wood were used as tools. After dissection, the wings were mounted and the other parts were put in small containers with 10% KOH for a period of about 12 hours at room temperature and then transferred to 70% alcohol for several hours. Hoyer's fluid was used to mount all the structures on slides, and proved to be superior for the wings and antennae; other media tried contract these structures and cause them to fold over or collapse.

The parts dissected and mounted from each female wasp were: head, antennae, mandibles, maxillo-labial complex, legs, wings, dorsum of thorax and abdomen, mesosternum, venter of abdomen and ovipositor. For males the structures dissected were: head, antennae, mandibles, legs, mesosomal dorsum (fused pronotum, mesonotum, metanotum, and propodeum), and abdomen. Once the slides were dry, the structures were projected for draw-

ing using a vertical micro-projector to facilitate outlining the structures. This type of projector proved to be best because the slides were horizontal at the time of projection and parts did not move. A phase microscope was used for details of the drawings.

Agaonid wasps from each species of *Ficus* from all localities and dates were dissected and identified in order to establish their specificity to the hosts.

In the descriptions, the number of sensilla per antennomere in the case of the female means the number of sensilla seen in dorsal aspect. In the case of male wasps, for the purpose of convenience, the prothoracic notum plus the fused mesonotum, metanotum, and propodeum are called "mesosomal dorsum." Unless otherwise stated the drawings were made in dorsal view.

The measurements are averages based on 10 specimens of each species, except as indicated in the footnote to Table 4.

BIOLOGICAL ACCOUNT OF NEW WORLD AGAONIDAE

In the New World figs the female flowers ("gall flowers" and reproductive female flowers) are intermixed with the male flowers and are scattered over all of the internal surface of the receptacle. The whole is termed a syconium or "fig fruit."

Agaonid females, after emerging from the ripe figs where they develop, search for a fig tree which possesses young figs at the right stage for pollination. Possibly the wasps are attracted by substances produced by the leaves and young receptacles. I have observed that for *B. cumanensis,* the pollinator of *Ficus* No. 4, several wasps were apparently attracted by the leaves, the wasps hovering near their edges. The possibility also exists that the syconium produces some kind of attractive substance when ready for pollination. In *Ficus* No. 4 the young syconia produce small drops of a translucent substance which accumulate on the exterior surface. This material did not have any detectable odor or flavor, but the receptacles which were in the right stage for pollination were very aromatic inside.

After the syconia buds appear, they remain small for a long period, then suddenly on any one tree all start growing almost simultaneously. Each species has a well defined period of development (pre-female phase) from the time that the syconia buds start growing to the time of penetration by the pollinators. This period is of course subject to weather conditions. I have found after several observations that for *Ficus* No. 4 this period is about 21 days.

When an agaonid lands on a young fig which contains female flowers in the receptive stage (female phase), she immediately moves about as though searching for the ostiole (the opening into the syconium). If it is a *Urostigma,* the *Blastophaga* locates the narrow slit below the most superficial ostiolar scale, raises the scale with the apical process of the first flagellomere,

and introduces the anterior part of the head in the opening, using the legs for pushing. Once the wasp has introduced the head, she uses the mandibles as a hold-fast while crawling between the scales. Each mandible possesses a proximal appendage which is armed with transverse ventral lamellae. The mandibles move alternately; the movements are so strong that the dorsal side of the head invaginates as a result of the contraction of muscles. The mandibular appendages and ridges prevent the wasp from moving back, permitting it only to move forward. About 15 minutes after it disappears under the most external ostiolar scale, her head appears at the internal opening of the ostiole. The wasp becomes completely free in the fig cavity in another 15 minutes. Contrary to the statements of Williams (1928), the abdomen is not particularly compressed in New World species and no liquid is squeezed out of it as the wasp enters the fig.

The ostiolar scales of the figs in subgenus *Urostigma* are located in such a way that the tunnel is first a helicoidal passage. Deeper in the ostiole the scales project inward, forming a straight channel. Thus a wasp entering the fig has to turn several times before she finds the straight portion of the ostiole. In her efforts at the time of entrance every wasp loses the wings and almost invariably also the last six flagellomeres. These parts are always left beneath the first, second, or third superficial ostiolar scales.

In *Pharmacosycea* figs, on the contrary, the ostiolar channel is a long tube which extends from the external ostiolar opening to the interior of the young fig. This channel is surrounded by scales all projecting toward the center; thus in *Pharmacosycea* the ostioles do not possess imbricated scales. Therefore the entering *Tetrapus* do not have to turn as *Blastophaga* do. *Tetrapus* wasps always reach the interior of the figs with complete antennae and wings.

An agaonid arriving at a tree with syconia in the right condition to be pollinated (female phase) seems to prefer a waspless one (apparently the wasp can distinguish whether a fig has been entered or not), but if more wasps arrive than the number of syconia present in the trees, then several wasps may penetrate the same fig. In 88 figs from a single tree (*Ficus* No. 4) I have found an average of 2 laying wasps per syconium (maximum 4, minimum 1).

In most New World species of *Ficus* almost every syconium of a tree is pollinated the same day, but in some pollination is over a period up to three days. If the young figs are not pollinated during this receptive period, even if wasps enter later, they stop growing, shrink and drop from the tree.

Once a *Blastophaga* is free inside of the fig, she walks around for several minutes. Using the remaining portions of the antennae, she searches the internal cavity and introduces the anterior part of her body among the stigmas, supposedly pollinating. In some cases the wasp spends more than an hour in this procedure. During this time she never uses the ovipositor, which is

located in the normal position and is directed posteriorly. After pollination the wasps start oviposition.

Probably the *Blastophaga* first pollinate all the female flowers (short- and long-styled) and next lay the eggs in the short-styled ones. The latter become gall flowers. The long-styled flowers are left presumably eggless due to the inability of the ovipositor to reach the ovary through the style.

The idea of pollination of all the flowers of the syconium (in male phase) prior to egg laying is supported by the finding of a single ripe syconium *(F. obtusifolia)* in Guanacaste, Costa Rica, which had only seeds, no galls. This syconium contained the remains of only one wasp, which I presume laid no eggs, so that all the flowers, short- and long-styled, developed into seeds.

Lerclerc du Sablon (1908) thought that flowers of caprifigs (=gall figs of *F. carica* L.) normally are pollinated and fertilized but that the development of their embryos is stopped by the growing wasp larvae. This idea was based on the observation that fertile achenes are frequently found among the gall flowers in mature caprifigs (Condit, 1932).

New World *Blastophaga* which are laying eggs are very aggressive towards each other, and if touched with a brush they bite the hairs and refuse to release them. Once several wasps have penetrated a single receptacle, a drop of latex plugs the ostiole; this latex is probably exuded from the lacerations produced on the ostiolar scales by the mandibles of the penetrating wasps.

In one tree of *F. turbinata*, wasps had entered a few figs on May 15, six days after the fruit buds started to grow. On May 16 at 7:00 a.m. 50% of the figs had wasps laying eggs; on May 17 at 3:00 p.m. eggs were being laid in all of the figs. The wasps were still laying eggs on May 18 at 8:30 p.m.; they remained very aggressive and their abdomens were compressed laterally. On May 19 at 3:30 p.m. the wasps were still alive but they were very quiet and egg laying had ceased. By this time the stigmas had wilted and the internal surfaces of the figs looked amber colored instead of white as they were at the time the wasps entered. On May 20 at 7:00 a.m. a few wasps were still alive but motionless. The new generation of wasps emerged from the ripe syconia about 30 days after their mothers entered the figs.

Wasps that have entered a fig never get out. Occasionally some apparently attempt to do so but die among the scales of the ostiole.

The period of development for each species of agaonid is apparently quite constant, being correlated with the ripening of the fig. I have recorded the period of development for the following species: *Blastophaga cumanensis*, 41 to 43 days in *Ficus* No. 4; *B. tonduzi*, 30 days in *F. hemsleyana; Blastophaga* sp. in *F. myriacycea*, 23 to 28 days; *B. baschierii* in *F. turbinata*, 26 to 30 days; and for the pollinator of *F. radula*, 27 days. At the end of the inter-

floral phase, almost all the syconia of a particular tree simulatneously increase rapidly in size and begin to soften. Once their volume is large enough in New World *Urostigma* figs a cavity is formed among the flowers inside the receptacle. In *Urostigma* the syconia usually start changing color at this period of development. As the figs begin to soften, the wasps become adults and the male flowers mature.

The first to emerge from the galls are the males which usually comprise less than 15% of the agaonid population of a fig. Each male makes a hole on the top of its gall to get out. Once out but still inside the syconium, a male finds a gall which contains a female of his own species, bites a hole in the top of the gall, introduces the telescoped abdomen through the opening and copulates with the female. The males are apterous and polygamous; each copulates with a number of females until no more virgins remain. After copulation (contrary to the observations of Grandi, 1961, for *B. psenes*) some males burrow out of the fig, usually through the ostiolar scales (in *Pharmacosycea* figs they always tunnel through the ostiolum) but in some *Urostigma* species they tunnel through any part of the fig wall. Several males usually make a tunnel simultaneously. Once they finish it, many of them drop to the ground. I have counted 2000 live males of *B. aguilari* per m^2 beneath a tree of *F. lapathifolia* from which wasps were emerging. If the males do not complete the tunnel, neither the female agaonids nor parasites can escape from the ripe figs.

The female wasps usually do not emerge from their galls until the exit tunnel has been completed. Then they emerge immediately. In the case of *Blastophaga* females, before they leave the syconium they go to the male flowers which are usually hidden under the galls and do not project into the internal cavity of the fig as far as the galls do. Each anther has two small slits which the wasps open with the antennal scapes and mandibles; through these openings the wasps remove the pollen from the anther sacks using the mandibles, front legs and possibly the antennae. They fill the four corbiculae (coxal and sternal corbiculae of Ramírez, 1969), and then go to the exits made by the males. Upon reaching the external surface of the fig, they clean the wings and abdomens using the hind legs, their heads are cleaned with the front legs. Next they fly to a fig tree of the same species in which they developed which possesses syconia at the right stage for pollination; they enter the figs, pollinate them and lay their eggs, thus initiating a new cycle.

In New World *Urostigma* there is usually no natural shedding of pollen with the exception of *F. tuerckheimii* in Costa Rica which is always pollinated and inhabited by two species of *Blastophaga* (*B. carlosi* and *B. mariae*). These two species are the only *Blastophaga* I have found in the New World which do not possess coxal corbiculae, and whose sternal corbiculae are very small in comparison to the *Blastophaga* inhabiting other species of *Urostigma*.

In *F. tuerckheimii* the anthers dehisce, shed the pollen, and the wasps become dusted with it at the time of their emergence from the galls.

After the normal emergence of the wasps from a *Urostigma* fig, almost all the anthers are wide open and empty. Every *Blastophaga* I have examined after emergence from its fig had the corbiculae full of pollen. However, wasps which had entered and died inside young figs after oviposition as a rule had the corbiculae empty or containing only a few grains of pollen.

In *Pharmacosycea* figs the anthers in the ripe figs are located more centrally than the gall flowers, and there is no true cavity. The anthers dehisce and shed the pollen, apparently without the help of the wasps. Thus the *Tetrapus* wasps which emerge from the galls inside the fig come in contact with the shed pollen and become completely dusted with it. To escape from the figs the females find the one exit which is made by the males through the ostiolum. The females apparently pollinate the young receptacles accidentally. Pollen was also found in the digestive tract of *T. costaricanus.*

In any particular area fig trees of the same species may be found with syconia in all phases of development (each tree with all syconia in the same stage of development). Thus it is possible for emerging females to find another tree of the same species with figs in the right stage for pollination. In this way fertilization is accomplished with pollen from a different tree.

The wasps always emerge at least one day before the fig is completely ripe. This mechanism saves the wasps from being eaten by birds, bats, and other animals that use the figs as a food.

SYSTEMATIC TREATMENT

New World Genera

The genus *Tetrapus* Mayr (1885) is adequately characterized by Grandi (1925) and the described Costa Rican species is keyed out below. The grouping of the American species of *Blastophaga,* however, requires discussion. At present there are thirty-four known species of New World *Blastophaga.* They were placed by Grandi (1963a) in five subgenera: *Julianella* (six species); *Tristaniella* (one species); *Valentinella* (seventeen species); *Secundeisenia* (two species); and *Pegoscapus* (one species). Seven others were placed by Grandi (1963a) in a special section because their wing venation was not known.

Grandi (1919, 1963b) used the venation of the front wing of the female as a main descriminatory character to distinguish *Julianella, Tristaniella,* and *Valentinella. Tristaniella* has complete humeral, marginal, stigmal, and postmarginal veins; *Valentinella* lacks the postmarginal vein (as in *Tristaniella* the costal cell is closed); and *Julianella* has an atrophied humeral vein, not reaching the edge of the wing, and the other veins are absent, the

costal cell open. Females of the other two subgenera, *Secundeisenia* and *Pegoscapus,* have front wing venation similar to that of *Valentinella;* these groups were recognized by Grandi largely for historical reasons.

The venational characters used by Grandi are variable and not correlated with other characters among the recognized subgenera. These subgenera, therefore, are not useful nor recognizable on any complex of characters. All new World *Blastophaga* should be placed under the subgeneric name *Pegoscapus,* as indicated in the following synonymy:

Subgenus **Pegoscapus** Cameron

Eisenia Ashmead, 1904, Mem. Carnegie Mus., 1(4):233. Type: *E. mexicana* Ashmead, 1904, by original designation. Not *Eisenia* Malm, 1877.

Pegoscapus Cameron, June 1, 1906, Primer Informe Anual de la Estación Central Agronómica de Cuba (1 Apr. 1904-30 June 1905), p. 275. Type: *P. longiceps* Cameron, 1906, by original designation.

Eiseniella Ashmead, July 13, 1906, Proc. Washington Entomol. Soc., 8:30. New name for *Eisenia* Ashmead. Not *Eiseniella* Michaelsen, 1900. For date of publication see Waterston, 1920.

Secundeisenia Schulz, 1906, Spolia Hymenopterologica, p. 146. New name for *Eisenia* Ashmead. (Schulz, on p. 356, cites *Eiseniella,* showing that *Secundeisenia* postdates *Eiseniella.*)

Allopade Strand, 1911, Arch. Naturgesch. (Berlin), 77(1):210. New name for *Eisenia* Ashmead.

Valentinella Grandi, 1919, Boll. Lab. Zool. Portici, 13:25. Type: *Blastophaga estherae* Grandi, 1919, designated by Gahan and Fagan, 1923, Bull. U.S. Nat. Mus., 124:1-173.

Julianella Grandi, 1919, Boll. Lab. Zool. Portici, 13:20. Type: *Blastophaga aguilari* Grandi, 1919, monobasic.

Tristaniella Grandi, 1936b, Boll. Ist. Entomol. Univ. Bologna, 26:239. Type: *Blastophaga astoma* Grandi, 1919, monobasic.

Female: Mandible with laminar process (appendage) with a variable number of transverse ridges (lamellae). Antenna with eleven free segments, pedicel in some species supplied dorsally with a very prominent subelliptical formation which occupies more than half of the segmental length. First flagellomere (third antennal segment) divided into two sections, a small proximal one and a distal scale-like elongate section. Second flagellomere subconical and usually without sensilla. Last seven flagellomeres with elongate sensilla and a variable number of bristles (some species possess also flattened bristles); last flagellomere with variable number of circular and elongate sensilla. Compound eye with minute hairs. Three ocelli present. Forewing usually with humeral, marginal and stigmal veins, but some species with postmarginal vein short, others with only humeral vein well developed, other veins being absent, transparent or spurious so that costal cell is open. Front coxa usually with an elongated cavity (coxal corbicula of Ramírez, 1969) on the mesal side (Fig. 98), fenced by a row of bristles on one side. Sternopleural region as illustrated by Grandi (1919, Fig. III). Mesosternum with two depressions (sternal corbiculae of Ramírez, 1969) partially covered by a flap (Fig. 101), so that they open medially, these depressions margined by two rows or groups of hairs, one anteriorly and the other posteriorly

(Fig. 97). Eighth abdominal tergum with spiracles and peritremata small and rounded. Ninth segment with two socii, each provided with a variable number of generally elongate setae. Ovipositor usually longer than length of abdomen.

Male: Head with a dorsal angular invagination which narrows caudally. Eyes laterodorsal and on extreme anterior portion of head. Dorsal surface of head covered with scattered small hairs. Antenna with four free segments (six segmented in *B. astoma* which lacks maxillolabial complex and mouth); last segment divided into three distinct parts, proximal and distal parts much smaller than medial; third segment sometimes also with a division. Maxillolabial complex usually present. Pronotum well differentiated; mesonotum, metanotum and propodeum fused dorsally. Sternopleural region as illustrated by Grandi (1919, Fig. XIII). Anterior tarsi two segmented, second segment with weak divisions. Middle leg well developed. Tenth abdominal segment without socii.

KEY TO DESCRIBED AGAONID WASPS FROM COSTA RICA

1. Front wing with incomplete humeral vein; marginal, stigmal and postmarginal veins absent; costal cell open 2
— Front wing with complete humeral vein; marginal and stigmal veins present, some species also with postmarginal; costal cell closed 3
2. Coxal and sternal corbiculae absent ..... *Tetrapus costaricanus*
— Coxal and sternal corbiculae present 4
3. Front wing with postmarginal vein atrophied 5
— Front wing with postmarginal vein present 6
4. Maxilla with 3 medial bristles ..... *Blastophaga aguilari*
— Maxilla with 4 medial bristles ..... *B. torresi*
5. Front leg with coxal corbicula 7
— Front leg without coxal corbicula 8
6. Last 7 flagellomeres with flat projecting bristles; front tibia with 3 apical teeth in anterodorsal side; apical process of hind tibia with 5 teeth ..... *B. urbanae*
— Last 7 flagellomeres with only slender bristles; front tibia with 2 teeth in anterodorsal side; apical process of hind tibia tridentate ..... *B. astoma*
7. Mandible with very small median and a very long projecting apical tooth (Fig. 118) ..... *B. jimenezi*
— Mandible with a medium size median tooth, apical tooth short, projecting 9
8. Body honey colored, head and thoraxic dorsum blackish; abdominal dorsum with a broad blackish spot. Coxae and femora honey colored ..... *B. mariae*
— Body, coxae and femora blackish ..... *B. carlosi*
9. Apical process of hind tibia with 1 or 2 teeth 10
— Apical process of hind tibia with 3 or more teeth 11
10. Apical process of hind tibia with 1 tooth; maxilla without median but with 2 subapical bristles ..... *B. ileanae*
— Apical process of hind tibia bidentate; maxilla with 1 median and 1 subapical bristle ..... *B. orozcoi*

11. Apical process of hind tibia annular with 4 large and 6 small teeth; maxilla with 2 or 3 median bristles ..... *B. estherae*
— Apical process of hind tibia not annular, with 3 teeth; maxilla without or with 1 median bristle 12
12. Maxilla without median bristle ..... *B. tonduzi*
— Maxilla with 1 medial bristle ..... *B. standleyi*

Descriptions of Seven New Species of Blastophaga from Central America and Venezuela

For all descriptions the characters are numbered to facilitate ready comparison among the descriptions. Certain measurements of all seven species are given in Tables 2 and 3.

Holotypes and allotypes will be placed in the collection of the U.S. National Museum. Paratypes will be in the Snow Entomological Museum, University of Kansas, and the collection of the author. Additional specimens are deposited in the British Museum (Natural History), in the Istituto di Entomologia, Università degli Studi di Bologna and in the Rijksmuseum van Natuurlijke Historie, Lieden.

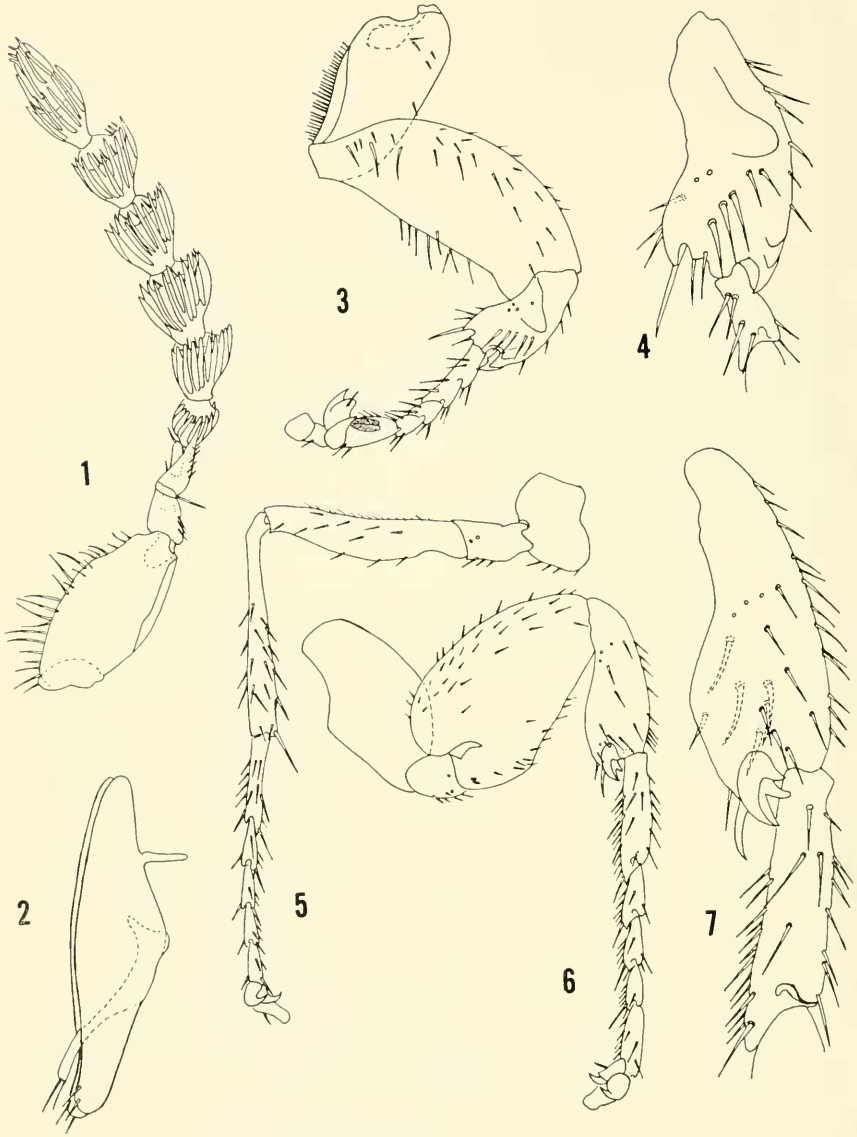
Blastophaga cumanensis new species

(Figs. 1-14, 97, 98)

Comparative comments. Female: This is the largest of the new species described. Its maxilla (Fig. 2) lacks median bristles as does *B. ileanae* (Fig. 91), but the former can be distinguished because of its size (body length 2.10 mm), its labium which has two apical bristles (one in *B. ileanae*), and because it has three teeth on the apical process of the hind tibia (Fig. 7) whereas *ileanae* has only one (Fig. 96). The front tibia in *B. cumanensis* has three anterodorsal apical teeth (Fig. 4) while *B. ileanae* has only two apical teeth (Fig. 93). *Male:* The mesosomal dorsum is quite narrow anteriorly in relation to the rest of the structure (Fig. 14). Its hind tibia has four medium sized and two small apical teeth (Fig. 13).

Types: Holotype female, specimen No. 1 (slide 921). Female paratypes: No. 2 (922), No. 3 (923), No. 4 (924), No. 5 (925), No. 6 (926-927), No. 7 (928-929-930-931), No. 8 (932). Allotype male, No. 9 (933). Male paratypes: No. 10 (934), No. 11 (935), No. 12 (936), No. 13 (937), No. 14 (938). *Host: Ficus* sp. (*Ficus* No. 4 of Venezuela). *Locality:* Cumaná, 15 Km along route to Puerto La Cruz, Estado Sucre, Venezuela. *Date:* June 27, 1966. Many other specimens of both sexes are preserved in vial No. 431.

Female: (1) Body length 2.10 mm; ovipositor 1.00 mm. (2) Head and dorsum of body blackish. (3) Scape, pedicel, and segment 1 of flagellum honey colored, rest of flagellum brownish. (4) Sides and venter of body lighter than dorsum. (5) Coxae and femora colored as sides of body, but with dorsal sides of femora darker; rest of legs honey colored. (6) Head



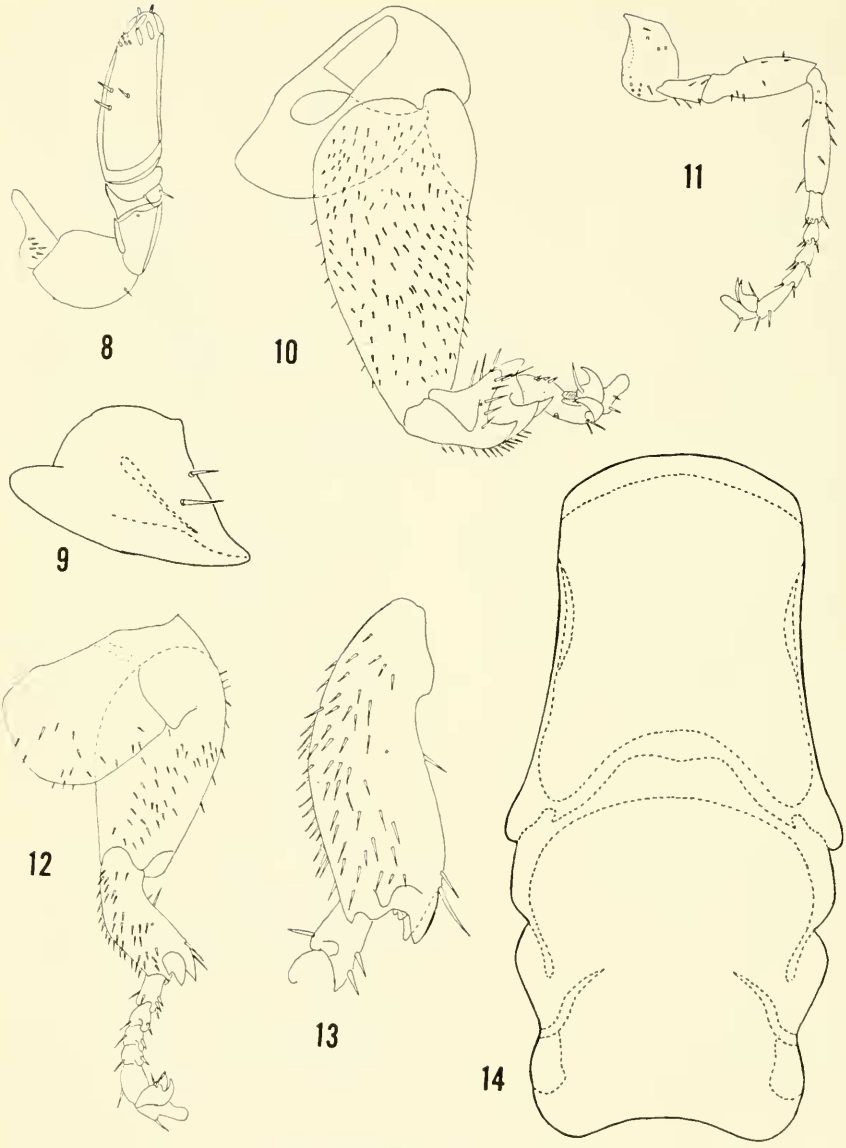
FIGS. 1-7. *Blastophaga cumanensis. Female:* **1,** antenna; **2,** maxillo-labial complex; **3,** front leg; **4,** front tibia; **5,** middle leg; **6,** hind leg; **7,** hind tibia.

subtriangular, slightly wider than long, posterior side slightly concave. (7) Compound eye as long as gena. (8) Premandibular projection without bristles; clypeus with 24 or 26 setae; epistomal margin with submedial lobes very prominent, medial lobe smaller than submedial ones. (9) Antennae

(Fig. 1) with scape suboval, length less than twice width; flagellomere 1 with apical process slightly surpassing apex of 2; 2 longer than wide; 3 to 8 with longitudinal sensilla; 3 wider than long, with 6 or 7 sensilla; 4 wider than long, with 8 or 9 sensilla; 5 larger than 4, wider than long, with 11 sensilla; 6 and 7 wider than long but narrower than 5, with 10 sensilla; 8 narrower than 7, with 9 sensilla; 9 subconical, much longer than wide, with 6 longitudinal and 3 circular sensilla. (10) Mandible (Fig. 106) bidentate, as long as wide, with 5 or 6 ventral ridges. (11) Mandibular appendage with 6 lamellae. (12) Maxilla (Fig. 2) with no medial bristles and 2 subapical bristles. (13) Labium (Fig. 2) with 2 apical bristles. (14) Front leg (Fig. 3): coxa with corbicula (Fig. 98), coxal length twice width; femoral length twice width; tibial length more than twice width, tibia with 3 apical teeth located anteriorly and one posteriorly (Fig. 4); tarsus with segment 1 shorter than 5; 2, 3, and 4 diminishing progressively in length, each shorter than 1. (15) Middle leg (Fig. 5): coxal width 1.5 × length; femoral length 4 × width; tibial length 6 × width; tarsus with segment 1 longest, 2 and 3 of equal length, longer than 5; 4 shorter than 5. (16) Hind leg (Fig. 6): coxal length less than twice width; femoral length 1.5 × width; tibial length more than twice width, apical process tridentate (Fig. 7); tarsus with segment 1 longest, segments 2 and 3 of equal length, 4 the smallest, 5 longer than 2. (17) Front wing length slightly more than twice width, humeral vein with 3 pustules, marginal much shorter than stigmal, stigmal with 4 pustules, postmarginal atrophied. (18) Hind wing length 4 × width. (19) Mesosternum: sternal corbicula (Fig. 97) with 7 to 9 hairs in anterior row and 7 or 8 located posteriorly; sternum with 13 or 14 hairs on each side.

Male: (20) Head slightly wider than long. (21) Antenna as in Figure 8. (22) Maxillo-labial complex lobiform with 3 apical lobelets, middle one with 2 apical bristles, main structure with 2 medial bristles. Mandible as in Figure 9. (23) Front leg (Fig. 10): coxal width almost 2 × length; femoral length almost twice width; tibial length twice width, 5 apical teeth (Fig. 11); tarsal segment 1 shorter than 2. (24) Middle leg (Fig. 11): coxa much wider than long; femoral length 3 × width; tibial length 4 × width; tarsus longer than tibia, segment 1 longer than 2; 2 and 3 equal length, 4 smallest, 5 longest. (25) Hind leg (Fig. 12): coxa much wider than long; femur much narrower than coxa, length twice width; tibia with 6 apical teeth (Fig. 13); tarsus shorter than tibia, segment 1 shorter than 5, 2 slightly longer than 3; 4 as long as 3 and fused to 5, 5 longest. (26) Mesosomal dorsum (Fig. 14) with length 1.40 mm, maximum width 0.74 mm, anterior width 0.45 mm, posterior width 0.48 mm.

This species is named for the location where it was studied, the town of Cumaná, Sucre, Venezuela.



FIGS. 8-14. *Blastophaga cumanensis*. *Male:* **8,** antenna; **9,** mandible; **10,** front leg; **11,** middle leg; **12,** hind leg (ventral view); **13,** hind tibia; **14,** mesosomal dorsum.

Blastophaga mariae new species

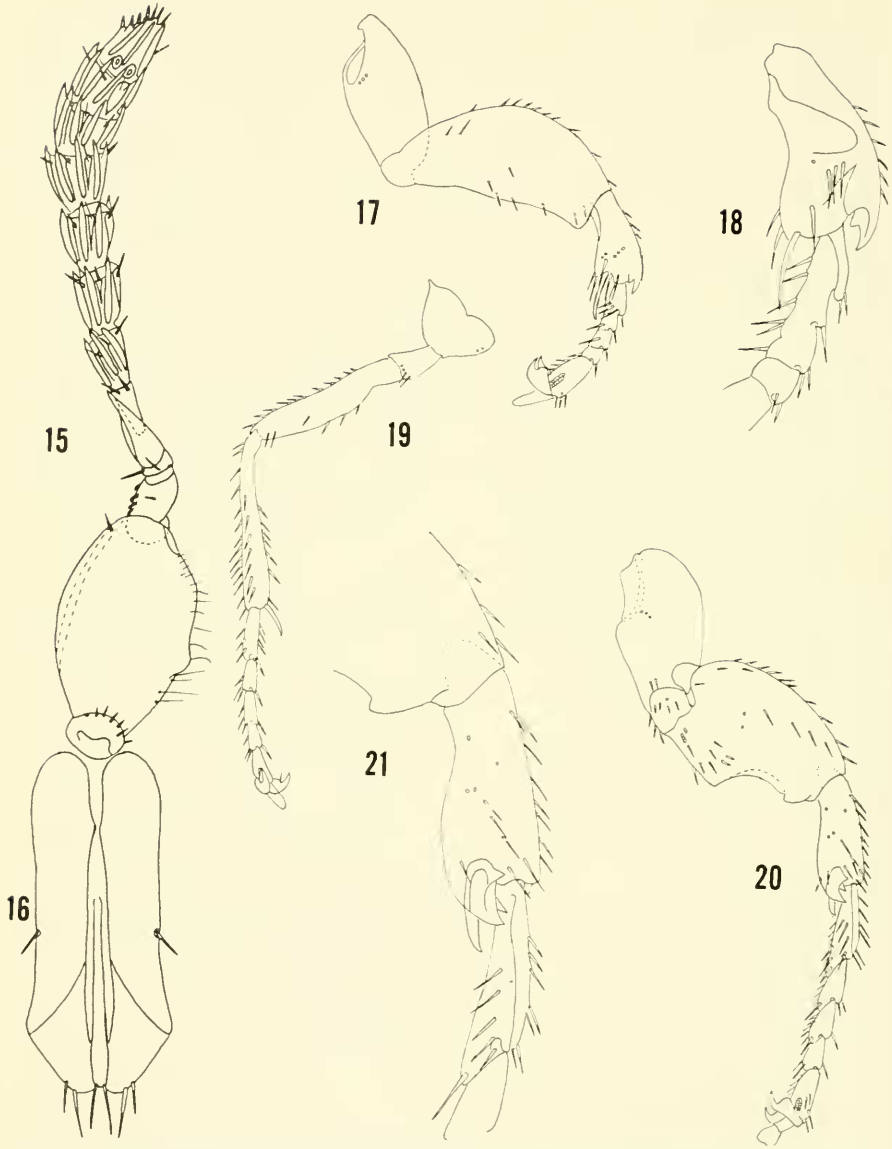
(Figs. 15-29, 102)

Comparative comments. *Female:* In size this is the second largest among newly described species (body length 1.70 mm). Its maxilla (Fig. 16) pos-

sesses 1 medial and 2 subapical bristles as in *B. carlosi* (Fig. 31) and *B. Standleyi* (Fig. 61) but *B. mariae* differs from these two species especially in coloration. The legs, venter and sides of the body are honey colored, the head, thoracic dorsum and mesal section of the abdominal dorsum blackish. The bodies of *B. carlosi* and *B. standleyi* are almost completely black. *B. mariae* differs also from *B. carlosi* by the 3 teeth on the anterodorsal side of the front tibia (Fig. 18), where *B. carlosi* possesses only 2. *Male:* Smaller than that of *B. cumanensis,* with the mesosomal dorsum (Fig. 29) much wider anteriorly than in the latter (Fig. 14). The hind tibia has 5 large apical teeth (Fig. 28).

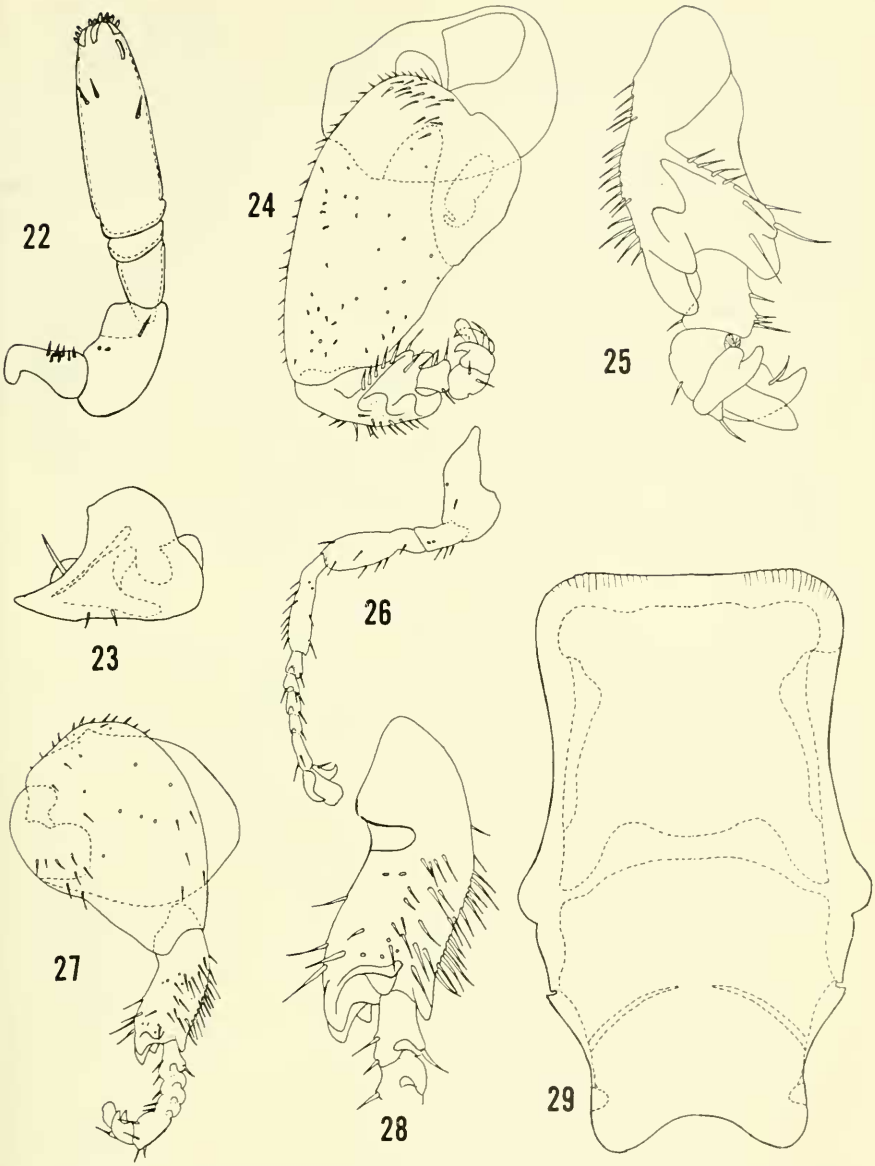
Types: Holotype female, specimen No. 1 (slides 944-945-946). Female paratypes: No. 2 (900-901), No. 3 (947), No. 4 (949), No. 5 (950), No. 6 (951-952-953). Allotype male, No. 7 (1292). Male paratypes: No. 8 (954), No. 9 (955). *Host: F. tuerckheimii* Stand. *Locality:* San Jerónimo de Moravia, San José, Costa Rica. *Date:* May 1, 1964. Many other specimens of both sexes are preserved in vial No. 149. Other specimens were taken at each of the localities for this *Ficus* listed in Table 1.

Female: (1) Body length 1.70 mm; ovipositor length 1.02 mm. (2) Head and dorsum of thorax blackish brown. (3) Scape, pedicel, and segment 1 of flagellum honey colored, rest of flagellum brownish. (4) Sides of body, venter of thorax and abdomen honey colored, medial section of abdominal terga 1 to 5 broadly blackish brown. (5) Legs honey colored, like sides of body. (6) Head (Fig. 102) subquadrangular, slightly longer than wide, posterior side concave. (7) Compound eye shorter than gena. (8) Premandibular projection with 3 stout short bristles; clypeus with 6 setae; epistomal margin almost straight, without submedial lobes, medial lobe very small (Fig. 102). (9) Antenna (Fig. 15) with scape suboval, length almost twice width; flagellomere 1 with apical process reaching apex of 2; 2 much longer than wide; 3 to 8 with longitudinal sensilla; 3 longer than wide, with 2 or 3 sensilla; 4 longer than wide, longer than 5, with 3 or 4 sensilla; 5 slightly longer than wide, with 5 sensilla; 6 as long as broad, with 5 sensilla; 7 and 8 shorter than 6, 8 narrower than 7, each with 5 sensilla; 9 subconical, with 3 longitudinal and 2 round sensilla. (10) Mandible (Fig. 107) bidentate, slightly wider than long, with 8 or 9 ventral ridges. (11) Mandibular appendage with 9 lamellae (some specimens with 7, 8, or 10). (12) Maxilla (Fig. 16) with 1 medial and 2 subapical bristles. (13) Labium (Fig. 16) with 2 apical bristles. (14) Front leg (Fig. 17): coxa without corbicula, length twice width; femoral length more than twice width; tibial length twice width, tibia with 3 apical teeth located anteriorly and 1 small posteriorly (Fig. 18); tarus with segment 1 longer than 2; 2, 3 and 4 of equal length; 5 longest. (15) Middle leg (Fig. 19): coxal width 2.5 $\times$ length; femoral length 3.5 $\times$ width; tibial length 5 $\times$ width; tarsus with



FIGS. 15-21. *Blastophaga mariae*. *Female:* 15, antenna; 16, maxillo-labial complex; 17, front leg; 18, front tibia; 19, middle leg; 20, hind leg; 21, hind tibia.

segment 1 longest, 2 longer than 3, 3 longer than 4, 4 shortest, 5 slightly shorter than 1. (16) Hind leg (Fig. 20): coxal length 1.4 × width; femoral length less than 1.5 × width; tibial length 3 × width, apical process tridentate (Fig. 21); tarsus with segment 1 longest, 2, 3, and 4 progressively



FIGS. 22-29. *Blastophaga mariae*. *Male:* 22, antenna; 23, mandible; 24, front leg; 25, front tibia; 26, middle leg; 27, hind leg; 28, hind tibia; 29, mesosomal dorsum.

diminishing in length, 5 longer than 2. (17) Front wing length more than twice width, humeral vein with 3 pustules, marginal slightly shorter than stigmal, stigmal with 3 pustules, postmarginal atrophied. (18) Hind wing length more than 3 × width. (19) Mesosternum: sternal corbicula with 5

to 8 hairs in anterior row and 1 or 2 located posteriorly; sternum with 5 or 6 hairs on each side.

Male: (20) Head wider than long. (21) Antenna as in Figure 22. (22) Maxillo-labial complex lobiform with 1 apical (some specimens 2) and 2 subapical bristles. Mandible as in Figure 23. (23) Front leg (Fig. 24): coxa much wider than long; femoral length almost twice width; tibial length twice width, 5 apical teeth (Fig. 25); tarsus of 2 subequal segments. (24) Middle leg (Fig. 26): coxa much wider than long, femoral length twice width; tibial length 4 × width; tarsus slightly longer than tibia, segment 1 longer than 2; 3 and 4 of equal length, longer than 2; 5 longest. (25) Hind leg (Fig. 27): coxa wider than long; femoral width same as coxa; tibia with 5 apical teeth (Fig. 28); tarsus shorter than tibia, segment 1 longer than 2; 2 and 3 equal length, 4 shortest; 5 longest. (26) Mesosomal dorsum (Fig. 29) with length 1.20 mm, maximum width 0.72 mm, anterior width 0.60 mm, posterior width 0.45 mm.

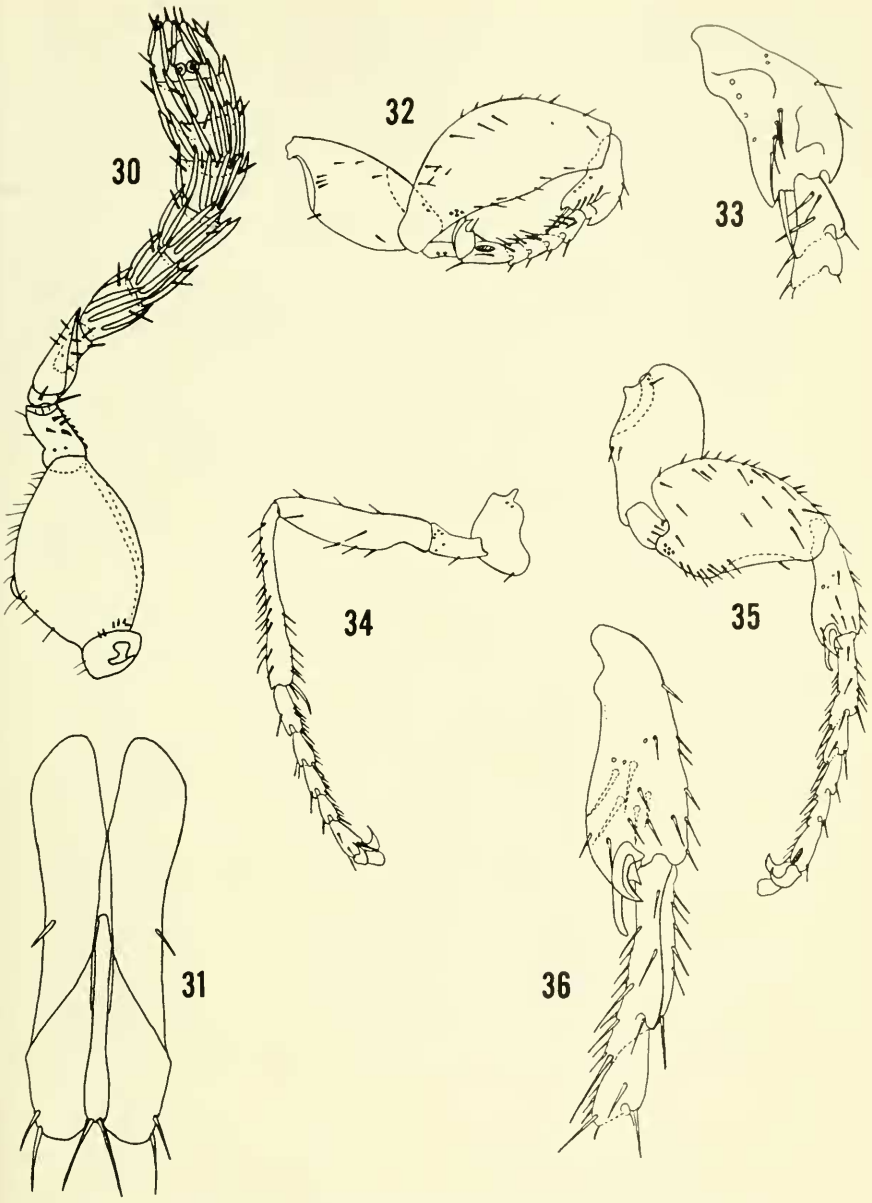
This species is named for Mrs. Mary H. Michener, formerly editor of the Journal of the Kansas Entomological Society.

Blastophaga carlosi new species

(Figs. 30-44, 99, 100, 103, 112)

Comparative comment. *Female:* This is the third species in size among species described (body length 1.67 mm). It is quite similar to *B. mariae.* Neither possesses coxal corbiculae (Fig. 100) and both have very reduced sternal corbiculae (Fig. 99). *B. carlosi* differs from *B. mariae* by its black color and some minor morphological characters. The antenna of *B. carlosi* (Fig. 30) has more sensilla per flagellomere; the head of *B. carlosi* is smaller (Fig. 103) with the epistomal margin bearing more prominent submedial and medial lobes than in *B. mariae,* in which this margin is almost straight (Fig. 102). The mandible in *B. carlosi* is smaller and possesses fewer lamellae (8-9) on the mandibular appendage (Fig. 112); *B. mariae* usually possesses from 8 to 10 (Fig. 107). Both species usually develop side by side in the same receptacles of *F. tuerckheimii,* or synchronously in different receptacles of the same fig tree. Male: Slightly smaller than male of *B. mariae,* its mesosomal dorsum (Fig. 44) very similar to that of *B. mariae* (Fig. 29). The front tibia (Fig. 40) differs from that of *B. mariae* (Fig. 25) because the apical tooth of the posterodorsal side is more pointed. The hind tibia has 5 large apical teeth (Fig. 43).

Types: Holotype female, specimen No. 1 (slide 1281). Female paratypes: No. 2 (886-887), No. 3 (898-899), No. 4 (940), No. 5 (941-942), No. 6 (1284). Allotype male, specimen No. 7 (886). Male paratypes: No. 8 (678), No. 9 (679-880), No. 10 (881-882), No. 11 (883-884), No. 12 (942), No. 13 (943). *Host: F. tuerckheimii* Stand. *Locality:* San Jerónimo de Moravia, San José,

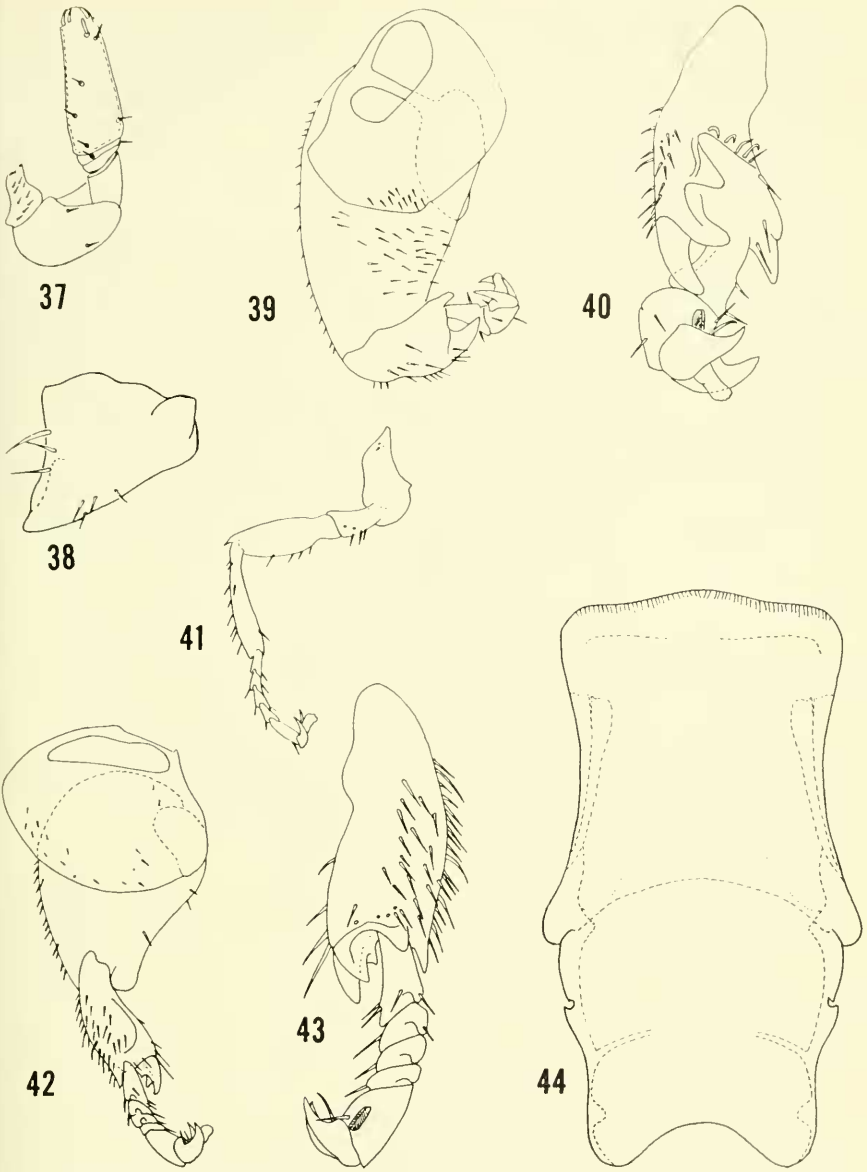


Figs. 30-36. *Blastophaga carlosi*. *Female:* 30, antenna; 31, maxillo-labial complex; 32, front leg; 33, front tibia; 34, middle leg; 35, hind leg; 36, hind tibia.

Costa Rica. *Date:* May 1, 1964. Many other specimens of both sexes are preserved in vial No. 159. Other specimens were taken at each of the localities for this *Ficus* listed in Table 1.

Female: (1) Body length 1.67 mm; ovipositor length 1.09 mm. (2) Head, thorax and abdominal venter black. (3) Scape, pedicel and segment 1 of flagellum honey colored, rest of flagellum brownish. (4) Sides of body and abdominal dorsum lighter than rest of body. (5) Coxae and femora black; tibiae and tarsi honey colored. (6) Head (Fig. 103) subquadrangular, slightly longer than wide, almost flat posteriorly. (7) Compound eye shorter than gena. (8) Premandibular projection with 3 or 4 short stout bristles; clypeus with 6 setae; epistomal margin with wide but slightly prominent submedial lobes, medial lobe conspicuous (Fig. 103). (9) Antenna (Fig. 30) with scape suboval, almost twice as long as wide; flagellomere 1 with apical process surpassing apex of 2, 2 much longer than wide; 3 to 8 with longitudinal sensilla; 3 longer than wide, with 4 or 5 sensilla; 4 slightly longer than wide, with 5 sensilla; 5 and 6 as broad as long, each with 6 or 7 sensilla; 8 much wider than long, with 7 sensilla; 9 subconical, with 5 longitudinal and 2 circular sensilla. (10) Mandible (Fig. 112) bidentate, slightly wider than long, with 8 or 9 ventral ridges. (11) Mandibular appendage with 8 or 9 lamellae (some specimens 7). (12) Maxilla (Fig. 31) with 1 median and 2 subapical bristles. (13) Labium (Fig. 31) with 2 apical bristles. (14) Front leg (Fig. 32): coxa without corbicula (Fig. 100), length twice width; femoral length more than twice width; tibial length twice width, tibia with 2 apical teeth located anteriorly and 1 posteriorly (Fig. 33); tarsus with segment 1 shorter than 5, segment 2 slightly shorter than 3; 3 and 4 of equal length, 5 longest. (15) Middle leg (Fig. 34): coxal width 1.5 × length; femoral length 4 × width; tibial length 5 × width; tarsus with segment 1 longest, 2 and 3 equal length, 4 shortest, 5 longer than 2. (16) Hind leg (Fig. 35): coxal length slightly more than 1.5 × width; femoral length more than 1.5 × width; tibial length 3 × width, apical process tridentate (Fig. 36); tarsus with segment 1 longest, 2 and 3 equal length, 4 smallest, 5 longer than 2. (17) Front wing length twice width, humeral vein with 3 pustules, marginal slightly shorter than stigmal, stigmal with 3 pustules, postmarginal atrophied. (18) Hind wing length 3 × width. (19) Mesosternum: sternal corbicula with 7 hairs in anterior row (some specimens with 6 or 8) and 2 located posteriorly; sternum with 4 or 5 hairs on each side (Fig. 99).

Male: (20) Head longer than wide. (21) Antenna as in Figure 37. (22) Maxillo-labial complex lobiform with 1 apical and 2 medial bristles. Mandible as in Figure 38. (23) Front leg (Fig. 39): coxal width twice length; femoral length almost twice width; tibial length twice width, 5 apical teeth (Fig. 40); tarsus of 2 segments of approximately equal length. (24) Middle leg (Fig. 41): coxa longer than wide; femoral length almost twice width; tibial length 4 × width; tarsus as long as tibia, segment 1 longer than 2; 2 smallest, 3 and 4 of equal length, 5 longest. (25) Hind leg (Fig.



FIGS. 37-44. *Blastophaga carlosi*. *Male:* 37, antenna; 38, mandible; 39, front leg (ventral view); 40, front tibia; 41, middle leg; 42, hind leg (ventral view); 43, hind tibia; 44, mesosomal dorsum.

42): coxa slightly wider than long; femur narrower than coxa; tibia with 5 apical teeth (Fig. 43); tarsus shorter than tibia, segment 1 twice as long as 2; 2 and 3 of equal length, and both longer than 4; 5 longest. (26) Mesosomal

dorsum (Fig. 44) with length 1.17 mm, maximum width 0.72 mm, anterior width 0.60 mm, posterior width 0.48 mm.

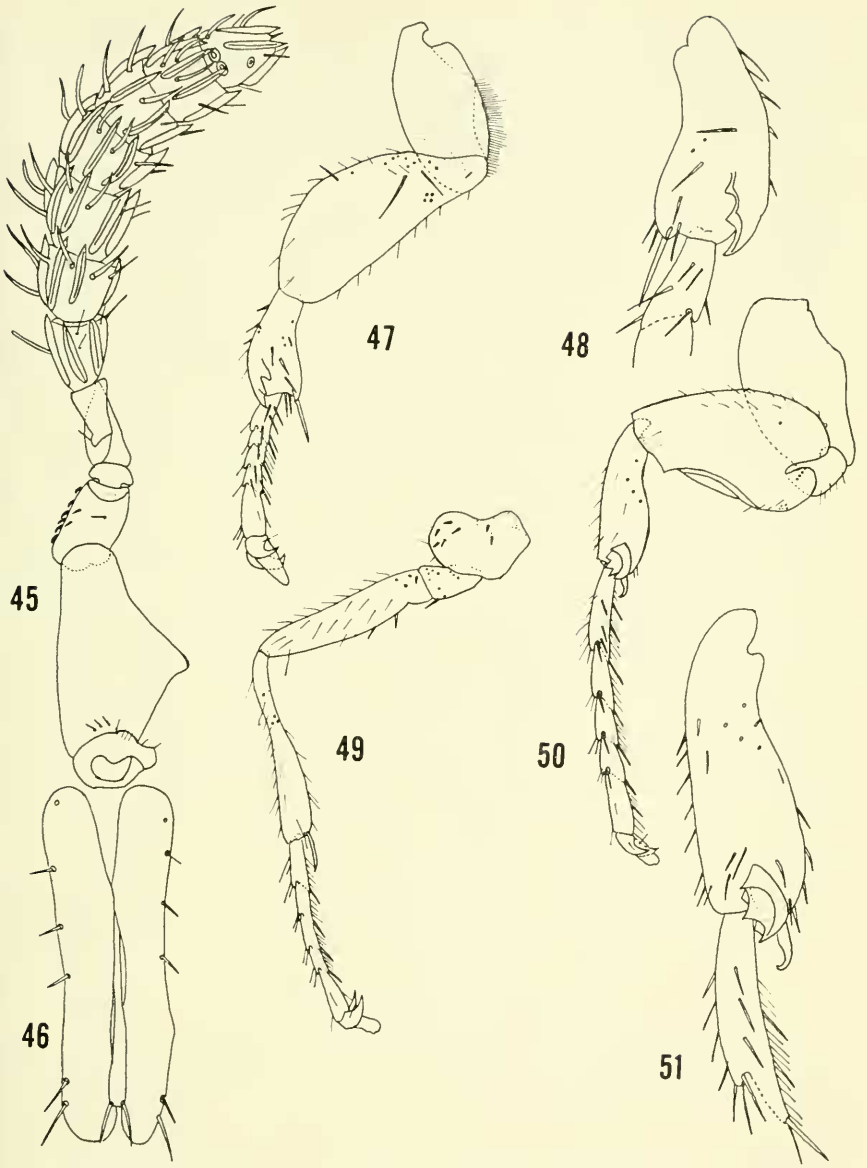
This species is named for my advisor, Dr. Charles D. Michener (University of Kansas).

Blastophaga urbanae new species
(Figs. 45-59, 116)

Comparative comments. *Female:* Much smaller than *B. carlosi* (body length 1.33 mm). This wasp possesses the most characteristic antenna of the group described. Its last 7 flagellomeres possess flat, long, projecting bristles (Fig. 45). Its maxilla has 4 medial (others 1 or none) and 2 subapical bristles (Fig. 46). The front wing has a short postmarginal vein (absent in other described species). Its hind tibia has the apical process with 5 teeth (Fig. 51) (other new species with 3 or less); in this respect *B. urbanae* resembles *B. estherae* Grandi. *Male:* Much smaller than male of *B. carlosi* with mesosomal dorsum quite narrow anteriorly (Fig. 59). The hind tibia has 4 large apical teeth (Fig. 58), other new species have 5 or 6 apical teeth in this position.

Types: Holotype female, specimen No. 1 (slides 875-876-877). Female paratypes: No. 2 (771), No. 3 (912-913-914-915), No. 4 (916-917-918), No. 5 (972-973-974), No. 6 (1035-1036), No. 7 (1406-1407-1408). Allotype male, No. 8 (869-870-871). Male paratypes: No. 9 (867-868), No. 10 (919), No. 11 (920). *Host: F. isophlebia* Stand. *Locality:* Ciruelas, Alajuela, Costa Rica. *Date:* August 20, 1964. Many other specimens of both sexes are preserved in vial No. 48. Other specimens studied were obtained as listed under the host in Table 1.

Female: (1) Body length 1.33 mm; ovipositor 0.68 mm. (2) Head and dorsum of thorax blackish amber. (3) Antenna with scape and pedicel honey colored, rest blackish. (4) Abdominal dorsum and venter of body lighter than rest of body. (5) Front and hind femora blackish, hind femur darker than front femur, rest of legs honey colored. (6) Head subtriangular, wider than long, posterior side concave. (7) Compound eye length equal to length of gena. (8) Premandibular projection with 2 long bristles; clypeus with 8 setae; epistomal margin with prominent, round, submedial lobes, medial lobe round and prominent but smaller than submedial ones. (9) Antenna (Fig. 45) with scape subtriangular, length less than twice width; flagellomere 1 with apical process reaching apex of 2; 2 longer than wide; 3 to 9 with long, projecting, flattened setae and longitudinal sensilla; 3 longer than wide, with 3 or 4 sensilla; 4 wider than long, with 4 sensilla; 5 wider than long, with 5 or 6 sensilla; 6 wider than long, with 5 sensilla; 7 to 9 forming a loose club; 7 shorter than wide, shorter than 6, with 4 or 5 sensilla; 8 as wide as long, with 5 sensilla; 9 subconical, slightly longer than 8, with 3 longitudinal



FIGS. 45-51. *Blastophaga urbanae*. *Female:* **45**, antenna; **46**, maxillo-labial complex; **47**, front leg; **48**, front tibia; **49**, middle leg; **50**, hind leg; **51**, hind tibia.

and 3 round sensilla. (10) Mandible (Fig. 116) bidentate, wider than long, with 10 ventral ridges. (11) Mandibular appendage with 12 lamellae (some specimens with 10 or 11). (12) Maxilla (Fig. 46) with 4 medial (some specimens with 3) and 2 subapical bristles. (13) Labium (Fig. 46) with 2

apical bristles. (14) Front leg (Fig. 47): coxa with corbicula; coxal length less than twice width; femoral length 2.5 × width; tibial length twice width, tibia with 3 apical teeth located anteriorly and 1 posteriorly (Fig. 48); tarsus with segment 1 shorter than 5; 2 and 3 of equal length, 4 shortest. (15) Middle leg (Fig. 49): coxal length 1.7 × width; femoral length almost 4 × width; tibial length 5.6 × width; tarsus with segment 1 longer than 5; 2 and 3 of equal length, 4 shortest. (16) Hind leg (Fig. 50): coxal length twice width; femoral length less than twice width; tibial length 3 × width, apical process with 5 teeth (Fig. 51); tarsus with segment 1 longest, 2 and 3 of equal length, 4 shorter than 3, 5 as long as 2. (17) Front wing length twice width, humeral vein with 3 pustules, marginal shorter than stigmal, stigmal with 3 or 4 pustules, postmarginal present. (18) Hind wing length almost 4 × width. (19) Mesosternum: sternal corbicula with 3 to 5 hairs in anterior row and 5 or 7 located posteriorly; sternum with 13 to 17 hairs on each side.

Male: (20) Head as long as wide. (21) Antenna as in Figure 52. (22) Maxillo-labial complex lobiform, with 2 medial bristles and 3 apical lobelets, middle one with 2 bristles. Mandible as in Figure 53. (23) Front leg (Fig. 54): coxal width 1.5 × length; femoral length more than twice width; tibial length twice width, 5 apical teeth (Fig. 55); tarsal segment 1 shorter than 2. (24) Middle leg (Fig. 56): coxa much wider than long; femoral length twice width; tibial length more than 4 × width; tarsus longer than tibia, segment 1 longer than 2; 2, 3, and 4 of equal length, 5 longest. (25) Hind leg (Fig. 57): coxa wider than long; femur narrower than coxa; tibia with 4 apical teeth (Fig. 58); tarsus longer than tibia, segment 1 shorter than 5; 2, 3, and 4 of equal length. (26) Mesosomal dorsum (Fig. 59) with length 0.90 mm, maximum width 0.49 mm, anterior width 0.36 mm, posterior width 0.33 mm.

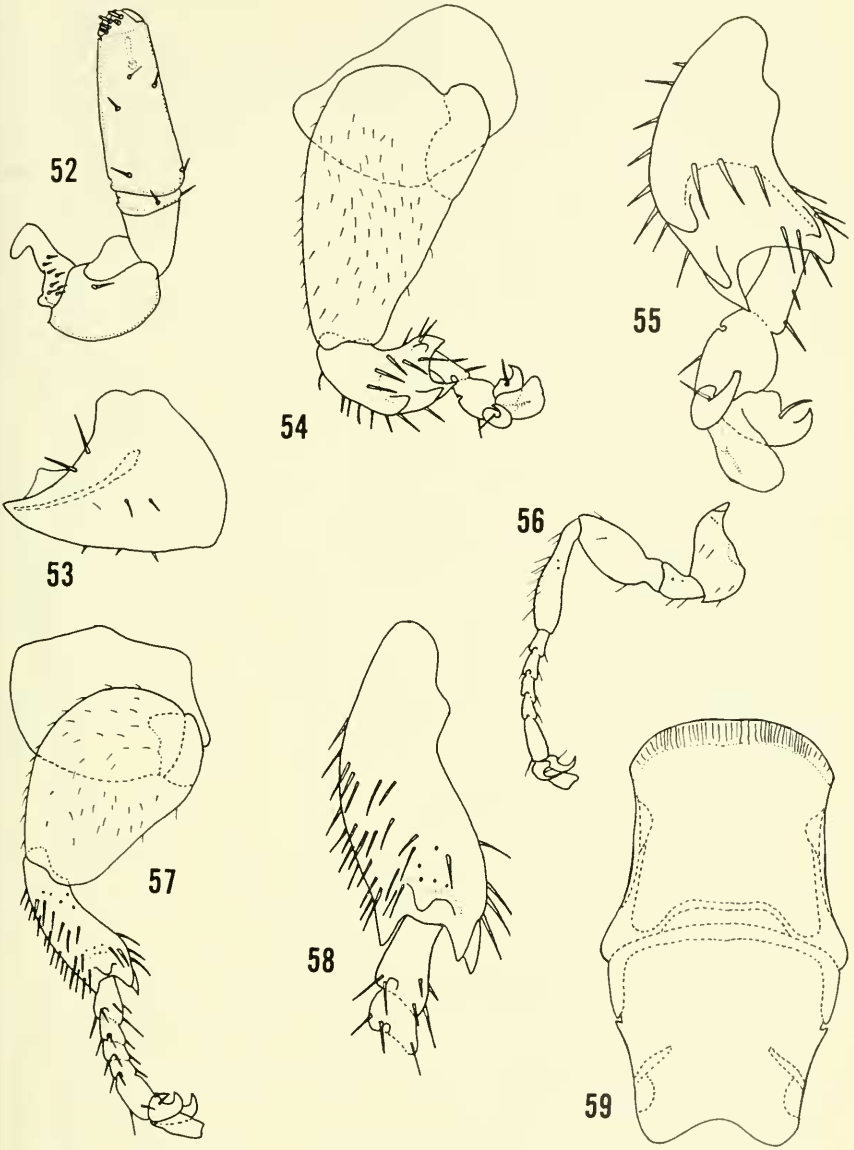
This species is named for my mother Mrs. Urbana Benavides de Ramírez.

Blastophaga standleyi new species

(Fig. 60-74, 119)

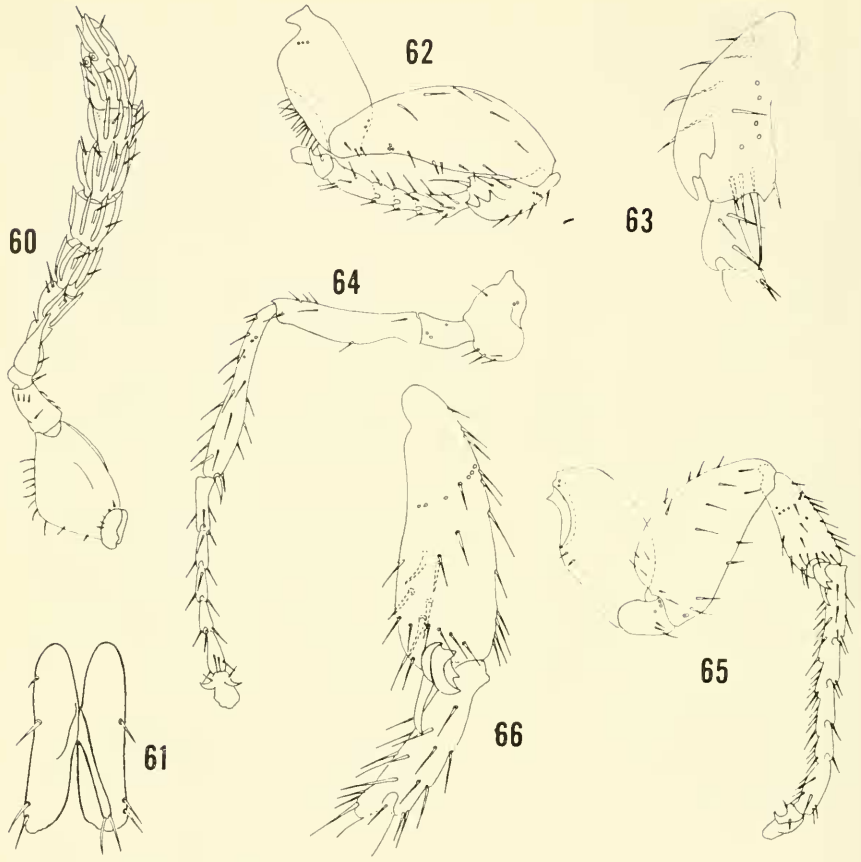
Comparative comments. *Female:* Smaller than *B. urbanae* (body length 1.03 mm). The mandible is bidentate as in the other new species, but the apical tooth is more elongate (Fig. 119), in this respect resembling *B. jimenezi* Grandi. The maxilla has 1 medial and 2 subapical bristles (Fig. 61), and the front tibia has 3 teeth on the anterodorsal side (Fig. 63). In the last two characters *B. standleyi* resembles *B. mariae,* but can be distinguished because of size and the presence of coxal corbiculae. *Male:* Much smaller than male of *B. urbanae* but the conformation of the mesosomal dorsum is quite similar (Fig. 74). The hind tibia has 3 big and 2 small apical teeth (Fig. 73).

Types: Holotype female, specimen No. 1 (slides 1045-1046). Female paratypes: No. 2 (860-861-862), No. 3 (863-864-865-866), No. 4 (1043-1044).



Figs. 52-59. *Blastophaga urbanae*. *Male:* 52, antenna; 53, mandible; 54, front leg; 55, front tibia; 56, middle leg; 57, hind leg; 58, hind tibia; 59, mesosomal dorsum.

Allotype male, No. 5 (857-858). Male paratypes: No. 6 (849-850), No. 7 (851-852-853), No. 8 (855-856). *Host: F. oerstediana* Stand. *Locality:* La Virgen, Heredia, Costa Rica. *Date:* May 31, 1964. Many other specimens of both sexes are preserved in vial No. 88.



FIGS. 60-66. *Blastophaga standleyi*. *Female:* 60, antenna; 61, maxillo-labial complex; 62, front leg; 63, front tibia; 64, middle leg; 65, hind leg; 66, hind tibia.

Female: (1) Body length 1.03 mm; ovipositor 0.56 mm. (2) Head blackish. (3) Scape and pedicel honey colored, rest of antenna blackish. (4) Dorsum of thorax blackish amber, abdominal dorsum and venter lighter than rest of body. (5) Front and hind coxae and femora blackish, front femur lighter than hind; rest of legs honey colored. (6) Head subhemispherical, slightly wider than long, posterior side almost straight. (7) Compound eye longer than gena. (8) Premandibular projection with 2 long bristles; clypeus with 8 setae; epistomal margin with prominent submedial lobes, medial lobe prominent but more acute than submedial ones. (9) Antenna (Fig. 60) with scape suboval, length less than twice width; flagellomere 1 with apical process surpassing apex of 2; 2 length less than twice width; 3 to 8 with longitudinal sensilla; 3 longer than wide, with 2 sensilla; 4 slightly longer than wide, with 4 sensilla; 5 to 7 subequal, wider than long,

each one with 4 or 5 sensilla; 8 narrower than 7, with 5 sensilla; 9 longer than wide, with 2 or 3 longitudinal and 2 circular sensilla (in some specimens 3). (10) Mandible (Fig. 119) bidentate, slightly wider than long, with 8 or 9 ventral ridges. (11) Mandibular appendage with 7 lamellae. (12) Maxilla (Fig. 61) with 1 median and 2 subapical bristles. (13) Labium (Fig. 61) with 2 apical bristles. (14) Front leg (Fig. 62): coxa with corbicula, coxal length more than twice width; femoral length almost 3 × width; tibial length more than twice width, tibia with 3 apical teeth anteriorly and 1 posteriorly (Fig. 63); tarsus with segment 1 longer than 2; 2 longer than 3; 3 and 4 of equal length, 5 longest. (15) Middle leg (Fig. 64): coxal width twice length; femoral length more than 4 × width; tibial length 7 × width; tarsus with segment 1 longest, 2, 3, and 4 of equal length, 5 longer than 4. (16) Hind leg (Fig. 65): coxal length 1.75 × width; femoral length 1.5 × width; tibial length 3 × width, apical process tridentate (Fig. 66); tarsus with segment 1 longest, 2 and 3 of equal length, 4 smallest, 5 longer than 2. (17) Front wing length slightly more than twice width, humeral vein with 3 pustules, marginal shorter than stigmal, stigmal with 4 pustules, postmarginal atrophied. (18) Hind wing length less than 4 × width. (19) Mesosternum: sternal corbicula with 6 or 7 hairs in anterior row and 3 or 5 hairs located posteriorly; sternum with 5 hairs on each side.

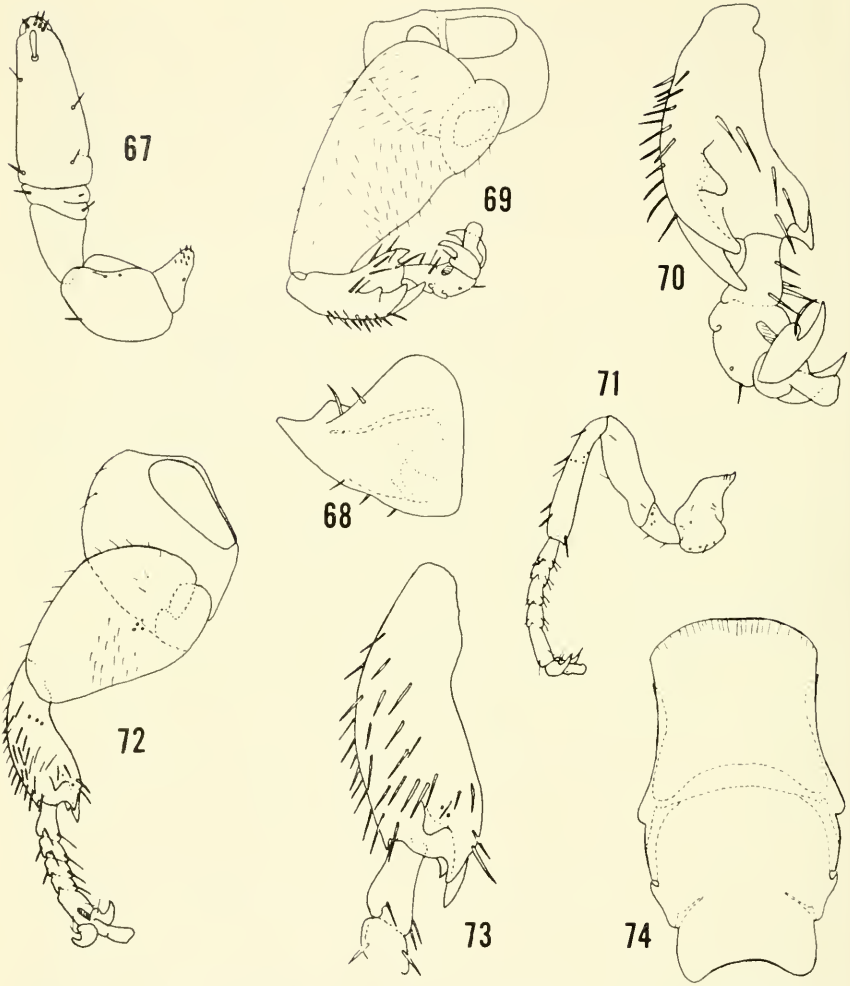
Male: (20) Head as long as wide. (21) Antenna as in Figure 67. (22) Maxillo-labial complex lobiform with 2 apical bristles. Mandible as in Figure 68. (23) Front leg (Fig. 69): coxal width 1.5 × length; femoral length 1.75 × width; tibial length more than twice width, 5 apical teeth (Fig. 70); tarsal segment 1 shorter than 2. (24) Middle leg (Fig. 71): coxa longer than wide; femoral length 2.5 × width, tibial length 6 × width; tarsus longer than tibia, segment 1 longer than 2, 2 smallest, 3 and 4 of equal length, 5 longest. (25) Hind leg (Fig. 72): coxa wider than long; femur narrower than coxa, length 1.6 × width; tibia with 5 apical teeth (Fig. 73) (in some specimens 6); tarsus as long as tibia, segment 1 shorter than 5; 2, 3, and 4 diminishing progressively in length. (26) Mesosomal dorsum (Fig. 74) with length 0.78 mm, maximum width 0.40 mm, anterior width 0.30 mm, posterior width 0.27 mm.

This species is named for the late plant taxonomist, Paul C. Standley, in recognition of his extensive work on Central American figs and other plants.

Blastophaga orozcoi new species

(Figs. 75-89, 120)

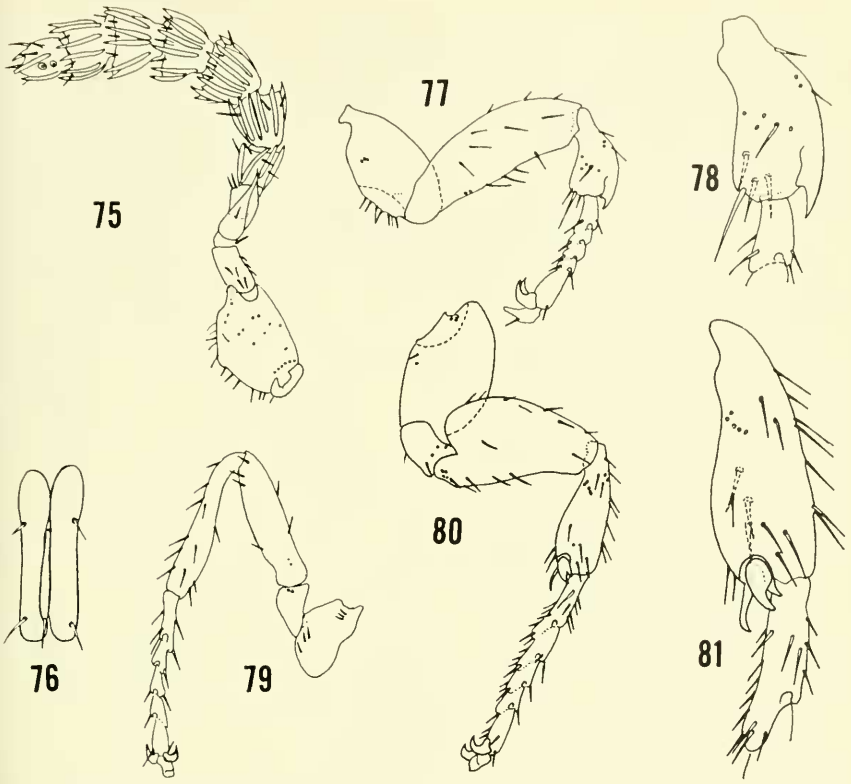
Comparative comments. *Female:* Smaller than *B. standleyi* (body length 0.94 mm). It can be distinguished from it because the maxilla has only 1 subapical bristle (Fig. 76) (*B. standleyi* has 2). The labium has 1 bristle while *B. standleyi* has 2. Its front tibia has 2 apical teeth on the anterodorsal



FIGS. **67-74.** *Blastophaga standleyi. Male:* **67,** antenna; **68,** mandible; **69,** front leg; **70,** front tibia; **71,** middle leg; **72,** hind leg; **73,** hind tibia; **74,** mesosomal dorsum.

side (Fig. 78), where *B. standleyi* has 3 (Fig. 63). The apical process of the hind tibia is bidentate (Fig. 81) instead of tridentate as in *B. standleyi, B. mariae,* and *B. carlosi. Male:* The smallest described as new. The anterior side of the mesosomal dorsum is quite narrow in relation to the rest of the structure (Fig. 89). The hind tibia has 3 large and 2 small apical teeth (Fig. 88).

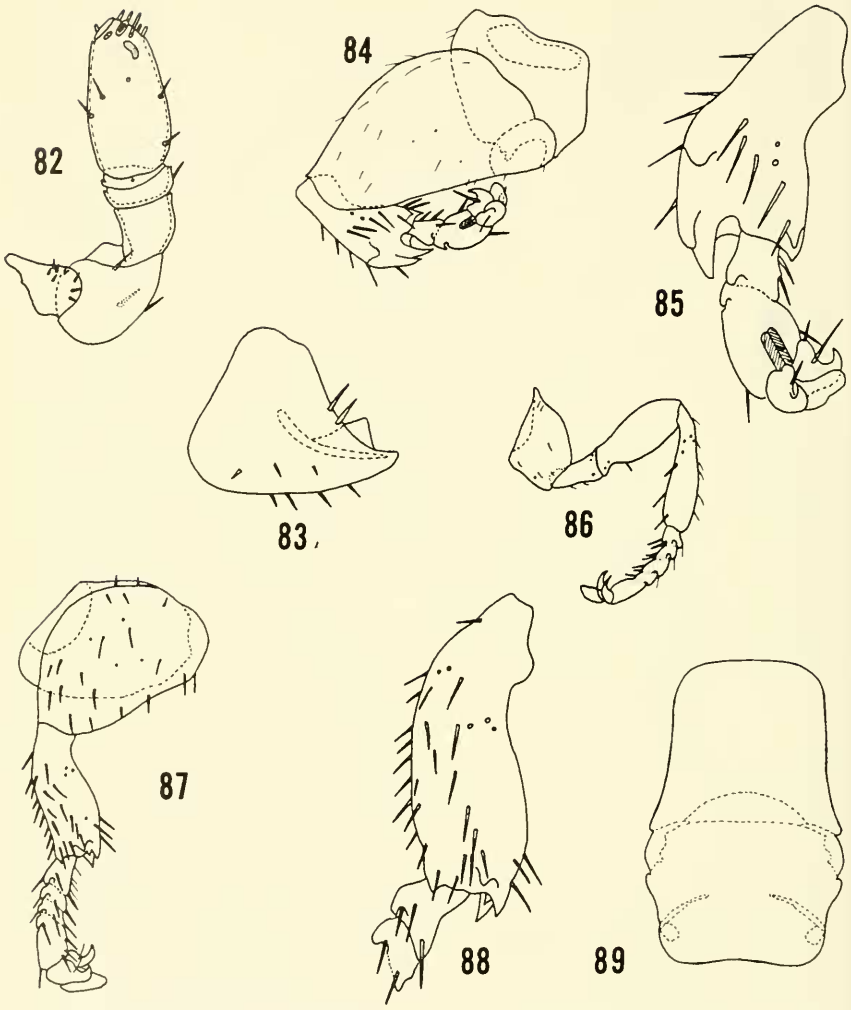
Types: Holotype female, specimen No. 1 (slides 1339-1340-1341). Female paratypes: No. 2 (848), No. 3 (1037-1038), No. 4 (1331), No. 5 (1332). Allotype male, No. 6 (846-847). Male paratypes: No. 7 (840-841), No. 8



FIGS. 75-81. *Blastophaga orozcoi*. *Female:* 75, antenna; 76, maxillo-labial complex; 77, front leg; 78, front tibia; 79, middle leg; 80, hind leg; 81, hind tibia.

(842-843), No. 9 (844-845), No. 10 (1042). *Host: F. colubrinae* Stand. *Locality:* Puerto Viejo, Heredia, Costa Rica. *Date:* May 16, 1964. Many other specimens of both sexes are preserved in vial No. 13.

Female: (1) Body length 0.94 mm; ovipositor length 0.38 mm. (2) Head and dorsum of body blackish amber. (3) Scape honey colored, rest of antenna blackish. (4) Body blackish with venter honey colored. (5) Front and hind femora blackish, rest of legs honey colored. (6) Head subtriangular, much wider than long, posterior side straight. (7) Compound eye much longer than gena. (8) Premandibular projection with 2 bristles; clypeus with 10 setae; epistomal margin rounded, submedial lobes very wide but not prominent, medial lobe wide and slightly prominent. (9) Antenna (Fig. 75) with scape suboval, length less than twice width; flagellomere 1 with apical process surpassing apex of 2; 2 slightly longer than wide; 3 to 8 with longitudinal sensilla; 3 wider than long, with 4 sensilla; 4 slightly wider than long, with 6 or 7 sensilla; 5 wider than long, with 6 or 7 sensilla; 6 and 7 with same dimensions as 5, each with 6 sensilla; 8 narrower than 7, with 6



FIGS. 82-89. *Blastophaga orozcoi*. *Male:* 82, antenna; 83, mandible; 84, front leg; 85, front tibia; 86, middle leg; 87, hind leg; 88, hind tibia; 89, mesosomal dorsum.

sensilla; 9 subconical, longer than wide, with 3 or 4 longitudinal and 2 circular sensilla. (10) Mandible (Fig. 120) bidentate, as long as wide, with 7 or 8 ventral ridges. (11) Mandibular appendage with 7 or 8 lamellae. (12) Maxilla (Fig. 76) with 1 medial and 1 subapical bristle. (13) Labium (Fig. 76) with 1 apical bristle. (14) Front leg (Fig. 77): coxa with corbicula, coxal length more than twice width; femoral length more than 3 × width; tibial length twice width, tibia with 2 apical teeth located anteriorly and 1 posteriorly (Fig. 78); tarsus with segment 1 longer than 2, shorter than 5; 3 and 4 of

equal length, 5 longest. (15) Middle leg (Fig. 79): coxal width almost twice length; femoral length 4 × width; tibial length 6 × width; tarsus with segment 1 slightly longer than 5; 2 and 3 of equal length but shorter than 1; 4 shorter than 3. (16) Hind leg (Fig. 80): coxal length less than twice width; femoral length twice width; tibial length 3 × width, apical process bidentate (Fig. 81); tarsus with segment 1 much longer than 5; 2 and 3 of equal length and shorter than 1; 4 slightly shorter than 3. (17) Front wing length slightly more than twice width, humeral vein with 2 pustules (some specimens with 3), marginal vein shorter than stigmal, stigmal with 2 pustules (some specimens with 3 or 4), postmarginal atrophied. (18) Hind wing length 5 × width. (19) Mesosternum: sternal corbiculae with 5 hairs in anterior row and 2 located posteriorly; sternum with 4 or 5 hairs on each side.

Male: (20) Head as wide as long. (21) Antenna as in Figure 82. (22) Maxillo-labial complex lobiform with 3 apical small lobelets, middle one with 1 apical and 2 basal bristles, main structure with 2 medial bristles. Mandible as in Figure 83. (23) Front leg (Fig. 84): coxa as wide as long; femoral length less than twice width; tibial length more than twice width, 5 apical teeth (Fig. 85); tarsal segment 1 shorter than 2. (24) Middle leg (Fig. 86): coxa as wide as long; femoral length slightly less than twice width; tibial length 4 × width; tarsus as long as tibia, segment 1 longer than 2; 2 and 3 of equal length, 4 shortest, 5 longest. (25) Hind leg (Fig. 87): coxa longer than wide; femur wider than coxa; tibia with 5 apical teeth (Fig. 88); tarsus as long as tibia, segment 1 shorter than 5; 2, 3, and 4 decreasing progressively in length, 5 longest. (26) Mesosomal dorsum (Fig. 89) with length 0.60 mm, maximum width 0.31 mm, anterior width 0.30 mm, posterior width 0.27 mm.

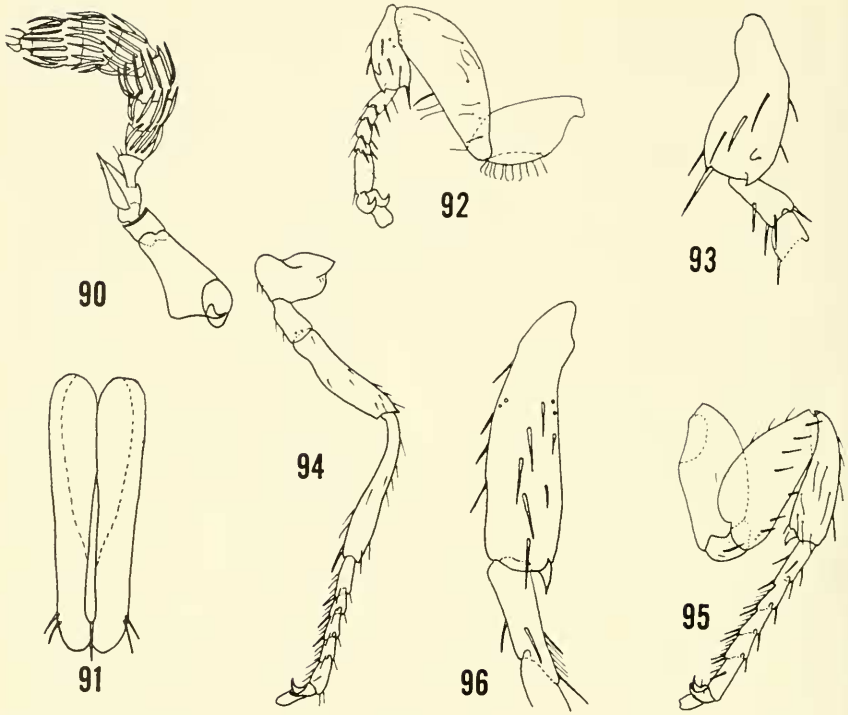
This species is named for my Costa Rican friend, Professor José María Orozco Cazorla, of the Ministerio de Agricultura y Ganadería, San José.

Blastophaga ileanae new species

(Figs. 90-96, 121)

Comparative comments: *Female:* This is the smallest wasp newly described (length less than 1.00 mm). The antenna has a very small last flagellomere (Fig. 90), less conspicuous than in the other species described. The maxilla possesses no medial bristles although it has 2 subapical ones, as in *B. cumanensis.* The labium has a single apical bristle (*B. cumanensis* has 2). The front tibia has 2 apical teeth on the anterodorsal side (Fig. 93) as in *B. orozcoi* (Fig. 78) but it differs from that and all the other new species described because its hind coxa has only 1 apical tooth (Fig. 96). *Male:* Unknown.

Types: Holotype female, specimen no. 1 (slides 1047-1048). Female paratypes: No. 2 (830-831), No. 3 (832), No. 4 (833-834-835), No. 5 (836).



FIGS. 90-96. *Blastophaga ileanae*. *Female:* 90, antenna; 91, maxillo-labial complex; 92, front leg; 93, front tibia; 94, middle leg; 95, hind leg; 96, hind tibia.

Host: F. schippii Stand. *Locality:* Puerto Viejo, Heredia, Costa Rica. *Date:* May 16, 1964.

Female: (1) Body length less than 1.00 mm. (2) Head and body blackish; (3), (4), and (5) unknown. (6) Head subtriangular, wider than long, posterior side slightly concave. (7) Compound eye longer than gena. (8) Premandibular projection without bristles; clypeus with 2 setae; epistomal margin with wide but not prominent submedial lobes, medial lobe acute and prominent. (9) Antenna (Fig. 90) with scape subtriangular, almost twice as long as wide, flagellomere 1 with apical process reaching apex of 2; 2 slightly longer than wide; 3 to 8 with longitudinal sensilla; 3 slightly longer than wide, with 5 or 6 sensilla; 4 as long as wide, with 6 sensilla; 5 and 6 subequal, wider than long, each with 7 sensilla; 7 to 9 forming a loose club; 7 wider than long, with 7 sensilla; 8 longer than wide, with 6 sensilla; 9 subconical, very small, apparently fused to 8, without sensilla. (10) Mandible (Fig. 121) bidentate (apparently unidentate), wider than long, with 5 or 6 ventral ridges. (11) Mandibular appendage with 6 lamellae (some specimens 7). (12) Maxilla (Fig. 91) with no medial and 2 subapical

bristles. (13) Labium (Fig. 91) with one apical bristle. (14) Front leg (Fig. 92): coxa with corbicula, coxal length twice width; femoral length 3 × width; tibial length twice width, 2 apical teeth located anteriorly and 1 very small one posteriorly (Fig. 93); tarsus with segment 1 longer than 2; 2 as long as 3; 4 shorter than 3, 5 longest. (15) Middle leg (Fig. 94): coxa much wider than long; femoral length 4 × width; tibial length 6 × width; tarsus with segment 1 as long as 5, segments 2 and 3 of equal length, 4 shortest. (16) Hind leg (Fig. 95): coxal length twice width; femoral length twice width; tibial length 2.7 × width, apical process unidentate (Fig. 96); tarsus with segment 1 longer than 5; 2 slightly longer than 3; 3 and 4 of equal length. (17) and (18) unknown. (19) Mesosternum: sternal corbiculae with 5 hairs in anterior row and 3 to 5 located posteriorly, sternum with 4 hairs on each symmetrical side.

(20) *Male:* Unknown.

This species is named for my daughter, Ileana María Ramírez L.

Comparative Comments on Neotropical Agaonidae and Their Hosts

This part consists of information on previously described neotropical agaonids, principally those now known to occur in Costa Rica, including some remarks on their hosts. Table 4 summarizes measurements and figures to show mandibles of females of these as well as the new species.

All the previously known agaonids studied in connection with this work were described by Guido Grandi (1919, 1920, 1925, 1934, 1938, 1952, and 1963b). Collection data for all species are those of the hosts as shown in Table 1.

Table 2. Sizes in mm of body, ovipositor and mandible of agaonid females described.

Blastophaga	Body length	Ovipositor length	Mandible length
B. cumanensis	2.10	1.00	0.27-0.30
B. mariae	1.70	1.02	0.25-0.29
B. carlosi	1.67	1.09	0.21-0.27
B. urbanae	1.33	0.68	0.16-0.20
B. standleyi	1.03	0.56	0.15-0.16
B. orozcoi	0.94	0.38	0.12-0.14
B. ileanae			0.10-0.11

Table 3. Dimensions in mm of mesosomal dorsum of agaonid males described.

	Length	Maximum width	Anterior width	Posterior width
B. cumanensis	1.40	0.74	0.45	0.48
B. mariae	1.20	0.72	0.60	0.45
B. carlosi	1.17	0.72	0.60	0.48
B. urbanae	0.90	0.49	0.36	0.33
B. standleyi	0.78	0.40	0.30	0.27
B. orozcoi	0.60	0.31	0.30	0.27

TABLE 4. Maximum, Minimum, and Average lengths in mm of the Mandibles of Females of 17 New World *Blastophaga*.

Blastophaga sp.	Minimum	Maximum	Average	Fig. No.
B. hoffmeyeri Grandi	0.300	0.325	0.324	105
B. cumanensis new sp.	0.288	0.325	0.297	106
B. mariae new sp.	0.250	0.288	0.270	107
B. torresi Grandi	0.225	0.288	0.257	108
B. astoma Grandi	0.238	0.263	0.256	109
B. amabilis Grandi	0.225	0.255	0.244	110
B. aguilari Grandi	0.225	0.250	0.235	111
B. carlosi new sp.	0.213	0.269	0.235	112
B. baschierii Grandi	0.200	0.250	0.229	113
B. estherae Grandi	0.213	0.238	0.226	114
B. tonduzi Grandi	0.183	0.220	0.198	115
B. urbanae new sp.	0.163	0.200	0.183	116
B. aemula Grandi	0.175	0.177	0.176	117
B. jimenezi Grandi	0.163	0.180	0.172	118
B. standleyi new sp.	0.150	0.162	0.155	119
B. orozcoi new sp.	0.119	0.137	0.130	120
B. ileanae new sp.	0.100	0.113	0.104	121

Blastophaga astoma has been placed in the subgenus *Tristaniella*. The female has the postmarginal vein in the front wing. Its mandibular appendage (Fig. 109) usually has 5 lamellae (some specimens only 4); other species studied have 6 or more. The maxilla possesses 1 medial and 2 subapical bristles. This is the only known agaonid in which the male is astomous.

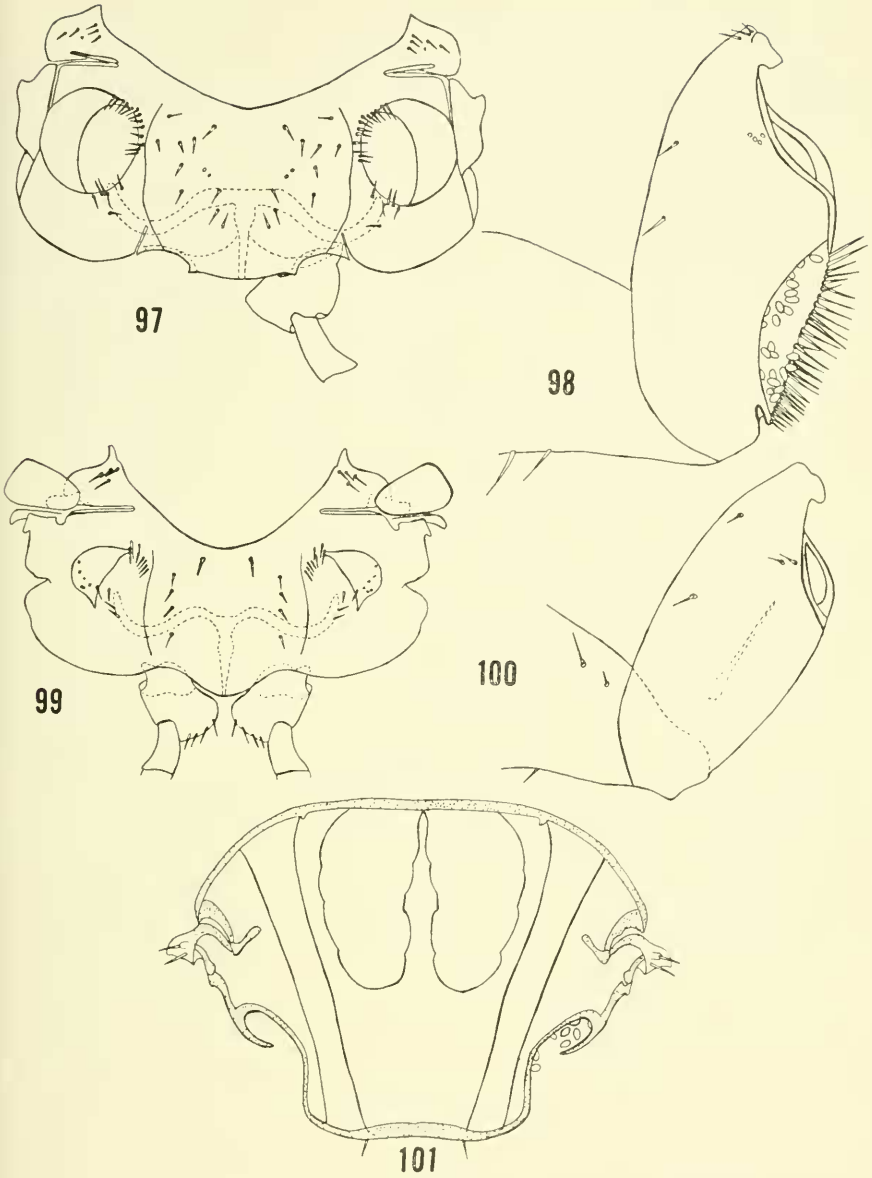
Host: *B. astoma* is the pollinator of *Ficus (Urostigma) torresiana*. Grandi (1920) reports that this species was collected in the receptacles of *Ficus (Pharmacosycea) crassiuscula* in Costa Rica, but this must certainly have been an error.

Blastophaga aguilari, B. baschierii, B. bruneri, and *B. torresi* have been placed in the subgenus *Julianella* because the humeral vein in the front wing is incomplete and the costal cell is open. Although these characters are variable and not correlated with others, the species are discussed in a group below.

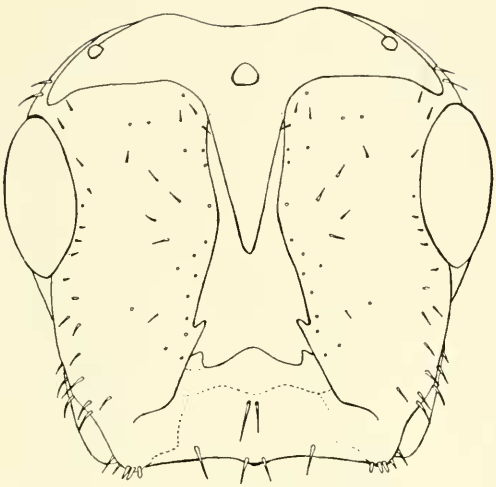
Blastophaga baschierii differs from the other three because its humeral vein ends in a distinctive clavola (Grandi, 1952, p. 52). The maxilla has 3 medial and 2 subapical bristles. The mandibular appendage possesses 7 or 8 lamellae (Fig. 113).

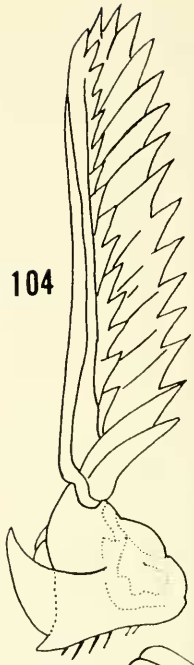
Host: Grandi (1952 and 1963a) does not report the host of *B. baschierii* and mentions as locality, Cuernavaca, Morelos, México. I have found this species pollinating and developing in the receptacles of *F. turbinata* in Venezuela and Panamá.

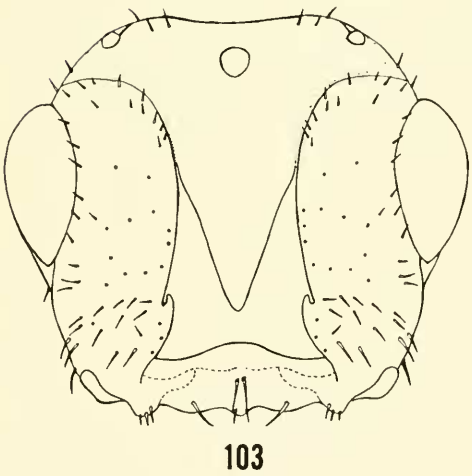
The females of *B. aguilari* are quite similar to *B. baschierii,* having similar chaetotaxy of the labium and maxilla, but the female of *B. baschierii* can be distinguished particularly because of the length of the fourth antennal seg-

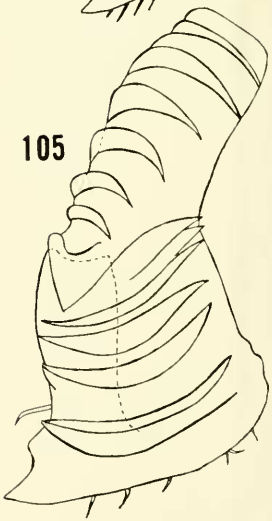


Figs. 97-101. Corbiculae of *Blastophaga*. 97, mesosternum of *B. cumanensis* showing sternal corbiculae (ventral view); 98, front coxa of *B. cumanensis* showing the coxal corbicula (ventral view); 99, mesosternum of *B. carlosi* showing sternal corbiculae (ventral view); 100, front coxa of *B. carlosi* without corbicula (ventral view); 101, cross section of mesothorax of *B. jimenezi* showing position and shape of sternal corbiculae (pollen grains in place on right side).









FIGS. **102-105.** **102,** head of *Blastophaga mariae;* **103,** head of *B. carlosi;* **104,** mandible of *Tetrapus costaricanus;* **105,** mandible of *B. hoffmeyeri.*

ment and the characteristic clavola and chaetotaxy of the front wing (Grandi, 1952). The mandibular appendage in *B. aguilari* has 7 or 8 lamellae (Fig. 111).

Host: I have found *B. aguilari* pollinating and developing in the receptacles of *F. lapathifolia* in Costa Rica, as Grandi (1919) reports.

Blastophaga torresi females differ from the other three species that have been listed in *Julianella* because its maxilla has 4 medial bristles (3 or 2 in the others). Its mandibular appendage has 7 or 8 lamellae (Fig. 108).

Host: This wasp is the pollinator of *F. velutina* as Grandi (1920) reports.

Blastophaga bruneri females differ from the other species listed in *Julianella* because its maxilla has only 2 medial bristles (other species have 3 or 4). Its mandibular appendage possesses 6 lamellae (some specimens 7) (Fig. 6 of Grandi, 1934).

Host: Grandi (1934) reports this species from receptacles of *F. coombsii* in Puerto Padre, Provincia de Oriente, Cuba. I found *B. bruneri* in the receptacles of a *Urostigma* species on San Andrés Island, Colombia. This fig was apparently also *F. coombsii*.

The other known *Blastophaga* studied are characterized by the humeral vein of the front wing reaching the edge of the wing, closing the costal cell, and by the presence of a stigmal vein.

B. jimenezi is easy to separate from the other species because its mandible possesses a very long apical tooth, so that it appears monodentate (Fig. 118). The only other New World *Blastophaga* known to me that possesses a similar mandible is the pollinator of *F. aurea* in Florida (not included here). The mandibular appendage of *B. jimenezi* usually has 6 lamellae (some specimens have 7 or 8) (Fig. 118).

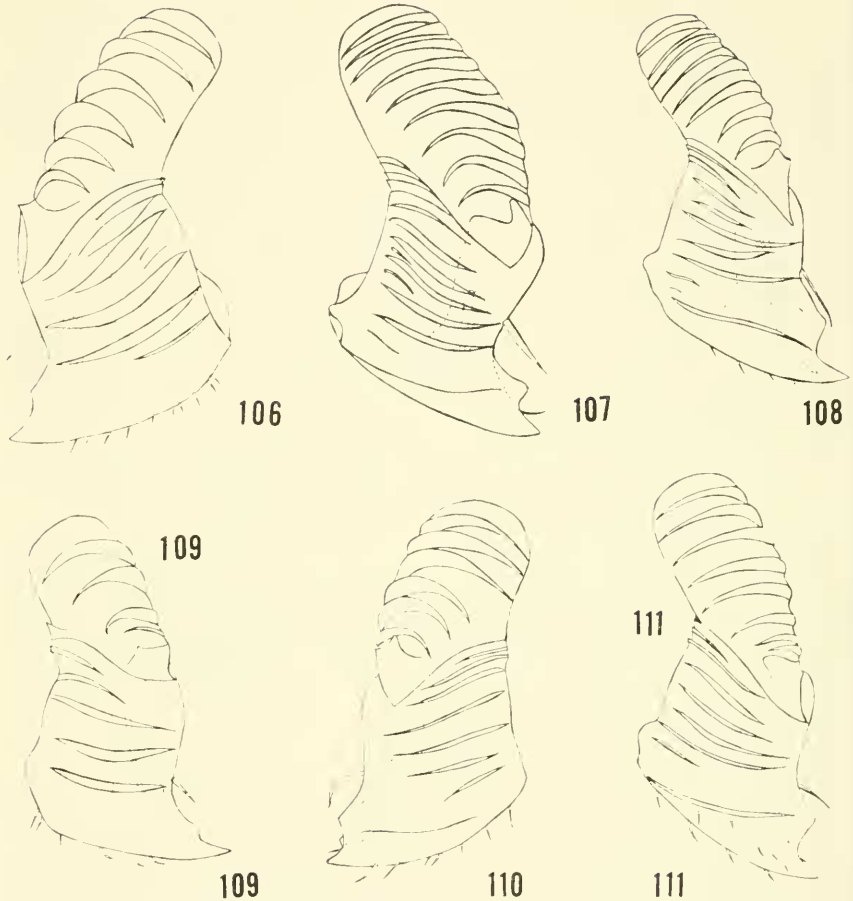
Host: *F. jimenezii* as Grandi (1919) reports.

Blastophaga estherae is easy to distinguish from the other species studied because the apical process of the hind tibia of the female is annular, and with a series of large and small teeth (Grandi, 1919, Fig. IV). The only species studied which possesses a similar hind tibia is *B. urbanae* (Fig. 51), but *B. urbanae* differs from *B. estherae* by the flat projecting bristles on the last 7 flagellomeres (Fig. 45). The mandibular appendage of *B. estherae* has 10 lamellae (Fig. 114) (Grandi, 1919, Fig. IV).

Host: *B. estherae* develops in the receptacles of *F. costaricana* in Costa Rica as Grandi (1919) reports. In some supposed *F. costaricana* I have found another undescribed species of *Blastophaga*.

Blastophaga tonduzi is easy to distinguish from the other species studied because the front tibia of the female has 2 apical teeth located anteriorly (Grandi, 1919, Fig. X). In this respect this wasp resembles *B. amabilis*, but they differ especially in the chaetotaxy of the maxilla; *B. tonduzi* has no medial bristles, while *B. amabilis* has 1 medial bristle. The mandibular appendage in *B. tonduzi* has 6 or 7 lamellae (Fig. 115).

Host: *B. tonduzi* develops in Costa Rica and in Venezuela in the receptacles of *F. hemsleyana*, as Grandi (1919) reports.

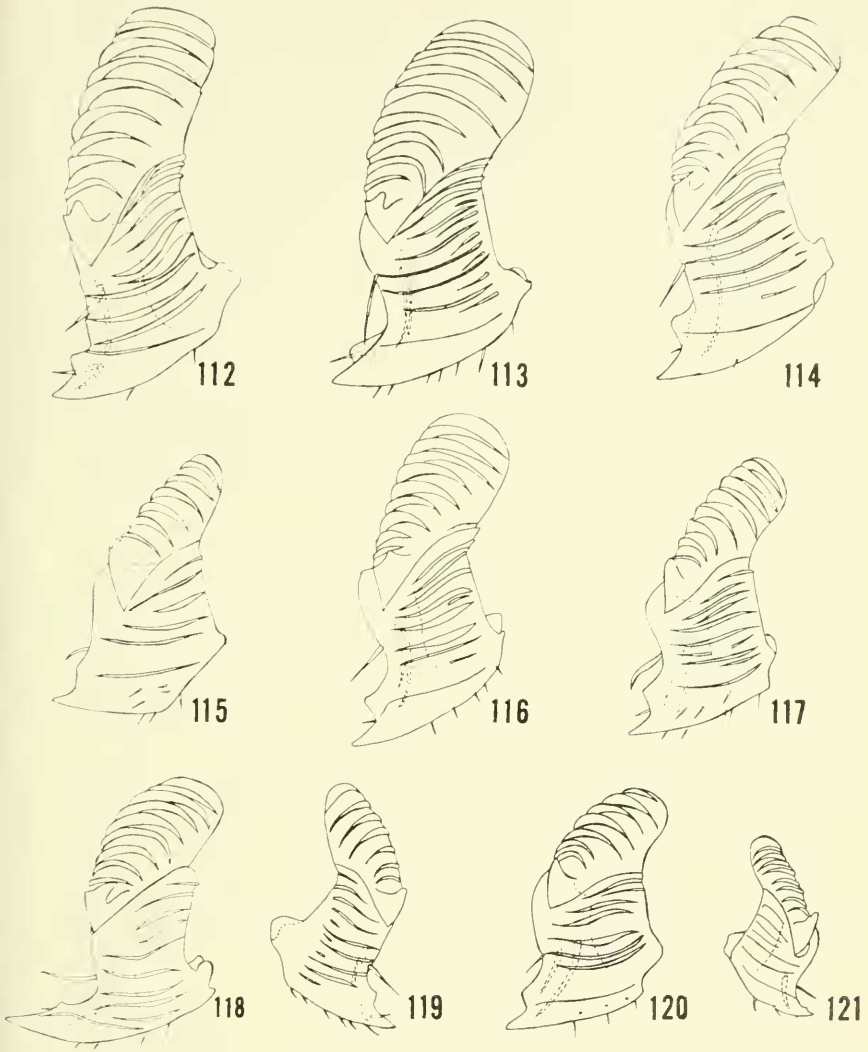


FIGS. 106-111. Mandibles of females. 106, *Blastophaga cumanensis;* 107, *B. mariae;* 108, *B. torrezi;* 109, *B. astoma;* 110, *B. amabilis;* 111, *B. aguilari.*

Blastophaga hoffmeyeri is the largest among the species studied and also possesses the largest mandible (Fig. 105). The female can be distinguished from the other known New World *Blastophaga* because of its subquadrangular scape (Grandi, 1934, Fig. IV) and its apparently tridentate mandible (Fig. 105). The mandibular appendage has 6 or 7 lamellae.

Host: I have found this wasp always developing in the receptacles of *F. obtusifolia* in Costa Rica and Panamá. Grandi (1934) described this species from Paraguay from an unknown fig.

B. aemula can be distinguished from other *Blastophaga* because of the chaetotaxy of the female labium, which has a single apical bristle. This is the only wasp of the group studied which possesses 3 apical teeth on the



Figs. 112-121. Mandibles of females. 112, *Blastophaga carlosi;* 113, *B. baschierii;* 114, *B. estherae;* 115, *B. tonduzi;* 116, *B. urbanae;* 117, *B. aemula;* 118, *B. jimenezi;* 119, *B. standleyi;* 120, *B. orozcoi;* 121, *B. ileanae*.

anterodorsal side of the front tibia combined with the labial chaetotaxy described. Its mandibular appendage has 8 lamellae (Fig. 117).

Host: If the identification of the wasp is correct, *B. aemula* develops in the receptacles of *F. trachelosyce* in Costa Rica. The specimens agree with Grandi's excellent drawings and description but Grandi (1938) reports this species from *F. luschnatiana* in Brazil, while stating that the identification

of the fig is not perfectly certain. DeWolf (1960) says that *F. trachelosyce* is found in Panamá and Colombia and probably in southwestern Costa Rica, but not Brazil.

Female *Blastophaga* found pollinating the receptacles of *F. nymphaeaefolia* are quite similar to *B. amabilis* but I am not sure about the identity of this wasp because I do not have males for comparison and because the labium of the specimens I have collected in Costa Rica possesses only one bristle instead of 2 as reported by Grandi (1938) for this wasp in Brazil. The mandibular appendage of females observed (Fig. 110) has 6 lamellae. Grandi (1938) reports the presence of 7 lamellae.

Host: DeWolf (1960) reports that *F. nymphaeaefolia* is found from Panamá to the mouth of the Amazon; thus the possibility exists that *B. amabilis* develops in Brazil also in the receptacles of the same fig.

Tetrapus costaricanus: The females possess mandibles with a very long, saw-like proximal process (Fig. 104) as in the majority of *Tetrapus* females, and the males are tetrapous.

Host: This wasp develops in the receptacles of *F. glabrata* in Costa Rica and Panamá. Grandi (1925, 1963a) does not report the host.

The pollinator of *Ficus crassiuscula* in Costa Rica is the most peculiar wasp of the genus *Tetrapus*. It will soon be described as a new species. The mandible of the female has 2 saw-like mandibular appendages, while the other known species possess only one. The males have three functional pairs of legs.

As shown above there are several discrepancies between the hosts of wasps studied and the reports of Grandi (1963a). Furthermore there are differences between the way DeWolf (1960, 1967) classifies some of the New World figs and the manner the agaonids use some of his species as biological units. The most important discrepancy is that *Blastophaga astoma* is the pollinator of *F. (Urostigma) torresiana* and not of *F. (Pharmacosycea) crassiuscula* as Grandi (1920) reported. DeWolf (1967) considers *F. (Urostigma) torresiana* to be a synonym of *F. (Pharmacosycea) macbridei.*

B. jimenezi is the specific pollinator of *Ficus jimenezii* as Grandi (1919) reports. DeWolf (1960) considers that *F. jimenezii, F. isophlebia,* and *F. tuerckheimii* are one species *(F. tuerckheimii).* I have found that *F. isophlebia* is the host of *B. urbanae, F. tuerckheimii* of both *B. mariae* and *B. carlosi.* Standley (1917) mentions these three species of figs from Costa Rica and considered them close relatives. These figs are found in Costa Rica growing in different zones and altitudes. *F. tuerckheimii* thrives above 1500 m, *F. jimenezii* is very common in the Central Valley and in the Pacific Zone at altitudes from approximately 800 m to 1500 m and *F. isophlebia* is found in dry lowlands of Guanacaste. *F. isophlebia* was described by Standley (1917) from David, Chiriquí, Panamá at altitudes from 30 to 80 m.

That *F. jimenezii* and *F. tuerckheimii* are possibly related species is revealed by the presence of a hybrid between the two at El Roble, Heredia, Costa Rica, where their ranges meet. This is the only hybrid I have found among New World figs. The young figs of this hybrid were entered by *B. jimenezi* (the pollinator of *F. jimenezii*) and by *B. mariae* and *B. carlosi* (the pollinators of *F. tuerckheimii*) but when the figs became ripe, reaching the size of ripe figs of *F. jimenezii*, only *B. jimenezi* appeared. *B. mariae* and *B. carlosi* did not develop.

B. estherae was found to use as host *F. costaricana*, as Grandi (1919) reports, but in some supposed *F. costaricana* trees I have found a different species of *Blastophaga*, not described. Two possibilities could explain the presence of two species of *Blastophaga* in this species. *F. costaricana* could be pollinated by two species of wasps as is *F. tuerckheimii*, or there may be in the Central Valley of Costa Rica a sibling complex of figs whose species can be recognized by the pollinators.

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